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NEW YORK, AUGUST, 1890.

IN connection with the table for Spiralizing Curves, sent by Mr. Franklin Riffle, Chief Engineer of the Oregon & Washington Railroad, and published in the JOURNAL for June, page 248, the fact should have been mentioned that the principles upon which the table are based are discussed in the book on Railroad Spirals, by Professor D. M. Greene, Troy, N. Y. The omission was accidental, and there was no intention to deprive Professor Greene of all due credit.

THE official trial of the *Philadelphia* over a 40-mile course at sea has shown that she is capable of making a speed of close upon 20 knots an hour and of keeping up that speed for a considerable time, making her one of the fastest, if not the fastest, cruisers of her size in existence. This result reflects great credit on her designers and builders, and will earn for the latter a considerable premium over the contract price. This result is based entirely on speed and not on power developed.

IN accordance with his expressed wish and the desire of the Swedish Government, the body of the late Captain John Ericsson is to be taken to his native country for final interment. In fitting recognition of his services the United States Government has detailed the war-ship *Baltimore* to carry his remains across the Atlantic. It is very seldom that such honors are paid to one who in his lifetime held no public office, but was simply a private citizen; but in Captain Ericsson's case no one can say that the honor thus given to his memory was not deserved.

EXPERIMENTS WITH LOCOMOTIVE BOILERS.

A REPORT has recently been published in the *Bulletin* of the International Railroad Congress of some very interesting experiments which have been made by M. A. Henry, Chief Engineer of the Paris, Lyons & Mediterranean Railroad, to determine the best conditions for economy in locomotive boilers having different lengths of tubes, with fire brick and also with water-arches. A special boiler was built with the same fire-box as is used on the passenger locomotives of that road, and with the tubes of the same diameter, = 2 in. The length of the tubes could be changed from 6½ ft. to 23 ft. if desired. To accomplish this, the boiler was formed of a series of rings which could be bolted together to produce any length desired. The boiler had 185 tubes, 2 in. outside diameter.

In making the experiments the draft was produced by a blower, and, excepting that required to feed the blower, the steam produced was allowed to escape into the atmosphere. The water was carefully measured and the ashes were collected after each trial from the grate, ash-pan, fire-box, tubes and smoke-box and weighed. Frequent analyses were made of the gases in the smoke-box, and their temperature was also measured. A water-gauge was placed between the ash-pan and smoke-box to measure the vacuum produced by the blower. Preliminary experiments showed that a vacuum of 1 in. of water is sufficient for a boiler of the type experimented with, with a light load, 1¼ in. under normal maximum conditions and 3 in. when working hard. It was also ascertained during the preliminary trials that it was best to charge the fire at the moment when the temperature of the gases began to diminish in the smoke-box, after having remained for a time at a maximum. An electric bell was therefore arranged in connection with the thermometer in the smoke-box, so that when the temperature began to fall the bell would ring, which was the signal for the fireman to charge the fire.

Besides the knowledge of the influence of the length of tubes, it was desired to ascertain the value of a long and a short brick arch, figs. 1 and 2, and also the Tenbrink water-arch or water-table, fig. 3. The fire-box of the boiler experimented with was made in such a manner that either the water-arch or the brick-arch could be used as desired.

Experiments were made with tubes varying from 3 meters (10 ft. nearly) to 7 meters (23 ft.), each with four series of trials; that is, one each with the ordinary fire-box, with long arch, with short arch and with the Tenbrink water-arch. Each of these series of trials was made with the three different amounts of vacuum named above. Each trial lasted about three hours. Persons interested in locomotive construction will find these experiments of very great interest, as none have ever been made which are so complete or which have been made in so thorough a manner. It is not easy to get at their significance without careful study, as so many different conditions were involved in producing the results, which were all plotted in separate diagrams. In order to explain the scope of the experiments, we have plotted on one diagram, fig. 4, all those with a plain fire-box, so as to make a comparison of the results easier and clearer. Having these clearly in mind, the effect produced by the brick and water-arches will be more easily understood.

In the diagram, *E F* at the bottom represents a tube 23 ft. long, and the vertical lines above it represent different lengths of tubes which were experimented with; the figures 3 m., 3.50 m., 4 m., etc., represent meters, and the scale below feet. The horizontal lines and the figures at each end indicate different quantities, which will be explained further on.

The experiments were made to determine first the quantity of coal which could be burned with various amounts of draft produced by the blower. The vacuum thus produced was measured by columns of water 1 in., 1¼ and 3 in. in height. The coal burned under these conditions with

different lengths of tubes is represented in the diagram by the three curves *A* 1 *A* 1, *A* 2 *A* 2 and *A* 3 *A* 3, all drawn in dark heavy lines. To explain the significance of these curves we will first take the lower one, marked *A* 1, which represents the coal consumed per hour with a vacuum of 1 in., and with tubes of 3, 3.50, 4, 4.50, 5, 6 and 7 meters in length, or very nearly equal to 10, 11½, 13½, 14¾, 16½, 19¾ and 23 ft., as shown by the scale at the bottom of the diagram. In relation to these curves the spaces between the horizontal lines and the figures at each end of them represent hundreds of kilograms = 220 lbs. of coal burned per hour, and the vertical distance 3 m. to *A* 1 of the curve *A* 1 above the base line *A F* represents the quantity of coal = 466 kilos. burned in a plain fire-box, with tubes 10 ft. long and a vacuum in the smoke-box measured by 1 in. of water. The vertical distance 3.50 *a* shows the quantity = 462 kilos. burned with tubes 3.50 meters or 11½ ft. long. In the same way the height of the curve above the base-line *E F* on the vertical lines 4 m., 4.50 m., 5 m., etc., represents the quantities of coal burned per hour with tubes of the lengths indicated by the figures. The figures on the vertical scale on the right-hand side of the diagram represent the quantity of coal burned per hour in hundreds of pounds.

It will be seen from this curve that, as the length of the tube is increased, the quantity of coal burned, with a draft due to a vacuum of 1 in., diminishes and falls from 1,025 lbs. with tubes 10 ft. long to less than 800 lbs. when they are increased to 23 ft.

The curve *A* 2 *A* 2 represents the coal consumed with a draft due to a vacuum of 1¾ in. From this it will be seen that with this amount of draft and tubes 10 ft. long the coal consumed per hour is increased from 1,025 to 1,430 lbs., and from 800 to 1,108 lbs., with 23 ft. tubes. The increase with the greater draft is almost uniform for the different lengths of tubes. The same remarks will apply to the curve *A* 3, which represents the coal burned with 3 in. of vacuum.

It will thus be seen that the quantity of coal burned is largely dependent upon the draft, a fact which is well known, and that it is diminished by increasing the length of the tubes, which it might have been surmised would be the case, but which has never been so clearly shown before.

The curves *B* 1, *B* 2 and *B* 3, represented in dotted lines, show the quantity of water evaporated per hour in the same way and under the same conditions as the coal was burned. In relation to these curves the figures at the ends of the horizontal lines represent thousands of kilos., and those on the vertical scale on the right-hand side of the diagram represent thousands of pounds. From these curves it will be seen that when the length of the tubes was increased beyond 10 ft. that the quantity of water evaporated was greater, although the coal burned was then less. The water evaporated reached its maximum with tubes between 14 and 15 ft. long. As might have been anticipated, the most efficient length of tube is somewhat greater with a strong than with a light draft. These curves show the importance of adequate length of tubes.

The curves *C* 1, *C* 2 and *C* 3, drawn in light lines at the top of the diagram, represent the quantity of water evaporated per unit of coal burned. The figures at the ends of the horizontal lines in this case may represent either kilos. or pounds, and show either how many kilos. of water are evaporated per kilo. of coal, or how many pounds of water per pound of coal. It will be seen that the curve representing the effects of a light draft is above, and that of a strong draft is below, thus showing that the quantity of water evaporated per pound of coal is greater with a light than with a strong draft. The effect of the length of the tubes on the evaporation per unit of fuel is also made very plain from these curves. The economy increases very rapidly with the length of the tubes from 10 up to about 15 ft., and from there up to the limits of the experiments it continues to increase, but not at so rapid a rate.

The curves, *D* 1, *D* 2, *D* 3, represented by light lines at the bottom of the diagram show the temperature in the smoke-box. The figures at the ends of the horizontal lines in this case represent hundreds of degrees Centigrade. These curves show that this temperature diminishes with the draft and is reduced by increasing the length of the tubes, and that the rate of reduction is greater from 10 to 15 or 16 ft. than it is after that.

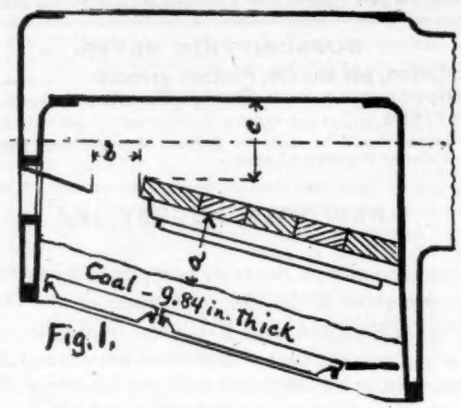


Fig. 1.

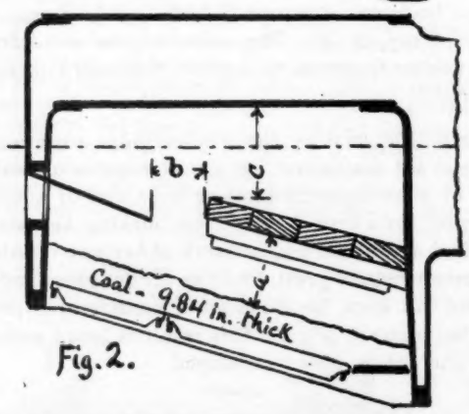


Fig. 2.

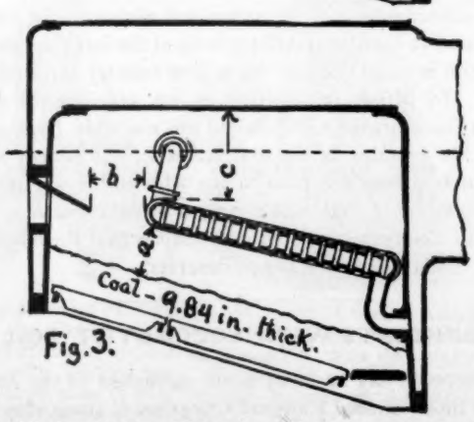


Fig. 3.

It was also shown, by collecting and weighing the cinders, that "in general, the long tubes result in a larger amount of cinder for a moderate vacuum than the short

tubes. For a strong draft the difference is much diminished, and it is not easy to distinguish any difference in the amount of cinders with a strong draft, whatever be the length of tube. The draft influences almost directly the quantity of cinders produced, and within the limits of the experiments made the cinders are sensibly proportioned to the vacuum or draft."

With a plain fire-box, the stronger the draft the less perfect was the combustion, but the influence of the length of the tubes on the completeness of the combustion appeared to be inappreciable.

To determine what would be the effect of reducing the number of tubes, some of them were stopped up. It was

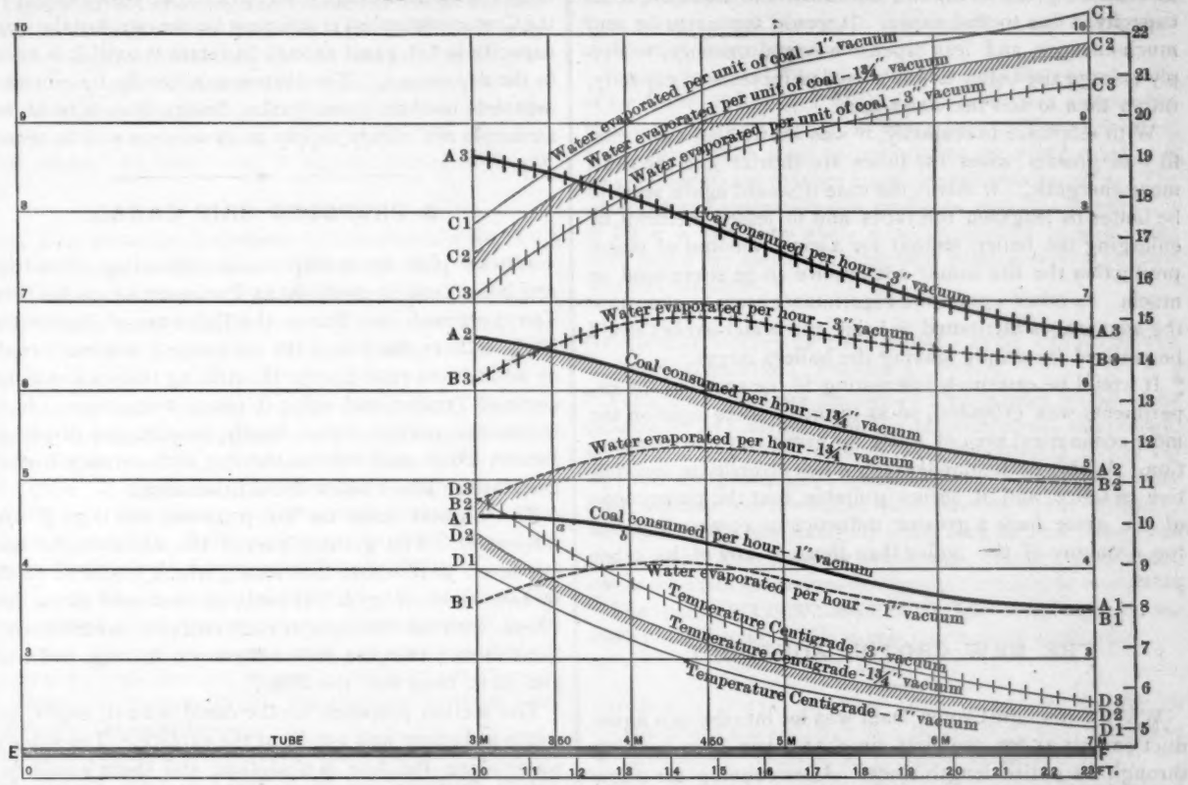

Water evaporated per unit of coal – 1" vacuum
Water evaporated per unit of coal – 1¾" vacuum
Water evaporated per unit of coal – 3" vacuum
Coal consumed per hour – 3" vacuum
Water evaporated per hour – 3" vacuum
Coal consumed per hour – 1¾" vacuum
Water evaporated per hour – 1¾" vacuum
Coal consumed per hour – 1" vacuum
Water evaporated per hour – 1" vacuum
Temperature Centigrade – 3" vacuum
Temperature Centigrade – 1¾" vacuum
Temperature Centigrade – 1" vacuum
TUBE
FT.

Fig. 4.

found that the coal burned and water evaporated per hour decreased as the number of tubes was decreased or stopped, but in a somewhat less proportion than that of the number of tubes suppressed. The economy of the boiler remained about the same.

The amount of water evaporated increases with the rate of combustion, but less rapidly.

The experiments with the brick and water-arches showed that the amount of coal burned per hour was diminished when they were used. The quantity of water evaporated per hour was increased with long tubes and diminished with shorter ones. The arches also increased the economy, or the water evaporated per pound of coal, but this increase was less with long than with short tubes, and with a moderate draft ranged from 6 to 12 per cent., according to the length of tubes, being greatest with tubes 10 ft. long. This economy diminished when the draft was increased.

The quantity of cinders was reduced very much by the arches, amounting to as much as 45 per cent. in some cases. They also gave a more complete combustion, and the volume of air used and the temperature in the smoke-box was less.

The important questions to be considered in regard to locomotive boilers are, first, their capacity, or the rapidity with which they will generate steam, and, second, their economy. With reference to the first, the experiments showed that the brick-arches diminished the capacity of the boiler from 2 to 10 per cent., and the water-arch increased it in some cases as much as 5 per cent. All the arches increased the economy of the boiler. This economy varied from 6 to 12 per cent., being greatest with short tubes and a strong draft.

The conclusions drawn by the experimenters are in favor of the use of either a brick or a water-arch; of tubes from 12½ to 14 ft. in length, and as many of them as can be used within the limits of weight to which the locomotive is confined. They also say that "a variation in the vacuum is the best means of giving to the locomotive a wide range of power, and to enable the regulation of that power to suit sudden demands made upon the engine." For that reason they suggest the use of a variable exhaust. It should be noted that the length of tubes recommended applies only to those 2 in. in diameter, as they were the only ones experimented with. The experiments are being continued, and they may throw some light on the question of the effect of various diameters of tubes.

As already remarked, the experiments are very interesting and throw much needed light on the question of the most efficient and economical length and number of tubes. The rate at which coal is burned has, however, much to do with the proportions of tubes. The maximum amount of coal burned during these experiments was 1,900 lbs. per hour. As the grate had an area of 24.2 sq. ft., the rate of combustion was 78½ lbs. per foot per hour. On another page will be found a report of experiments made on the Baltimore & Ohio Railroad, showing rates of combustion of 133.2, 148.1 and 193.1 lbs. per sq. ft. per hour, or more than double the maximum rate of the experiments on the Paris, Lyons & Mediterranean Railway. This comparison shows, what has been known before, that locomotives in this country are worked much harder than they are worked

in Europe, and the question very naturally arises whether the lengths of tubes which were found to be best suited for burning coal at the rate of 78½ lbs. per square foot per hour would be the best for burning more than double that quantity.

In the light of the experiments there is, however, room for dissent from the conclusions which have been drawn in favor of the use of brick or water-arches. It is admitted in this respect that brick-arches diminish the steam-producing capacity of the boiler, and the water-arch increases it about 3 per cent. This percentage is just about equal to the proportion that the heating surface of the boiler is increased by the arch, and doubtless the addition to its capacity is due to that cause. It would appear to be very much cheaper, and less expensive in maintenance, to simply enlarge the boiler to get a needed increase of capacity, rather than to add the water-arch.

With reference to economy, it was shown that this benefit was greater when the tubes are shorter and the draft more energetic. If this is the case it would again seem to be better to lengthen the tubes and to lessen the draft by enlarging the boiler, so that for a given amount of steam production the fire would not require to be stimulated so much. In other words, the experiments seem to show that the advantages attributed to brick and water-arches could be realized by simply making the boilers larger.

It would be extremely interesting if the scope of the experiments was extended, so as to throw some light on the most economical area of grate for given rates of combustion. In this particular there is much diversity in locomotive practice, and it seems probable that the proportions of the grate have a greater influence on combustion and the economy of the boiler than those of any of its other parts.

THE NEW CROTON AQUEDUCT.

WATER from the Croton Dam was let into the new aqueduct on July 15 for the first time, and has been running through its entire length since. After running for a few days the water was shut off to permit a careful examination, but it is now in regular use. It has been five years under construction.

The length of the aqueduct proper is 30.75 miles, from Croton Lake to the gate-house at One Hundred and Thirty-Fifth Street in New York City. From that point to the main reservoir in Central Park, 2.37 miles, it is continued by a system of iron pipes, so that the total distance from Croton Lake to the reservoir is 33.12 miles. The length in tunnel is 29.63 miles, and 1.12 miles are in open trench.

From Croton Lake to a point near Jerome Park the aqueduct is oval in section, 13.53 ft. high and 13.6 ft. wide, and its estimated capacity is 318,000,000 gallons daily. At that point a large reservoir is to be built to supply the northern part of the city. South of that point the section is circular, 12.25 ft. in diameter, and its total capacity 250,000,000 gallons daily. At the lower gate-house the water is transferred to 12 iron pipes, 48 in. in diameter.

Blow-outs for emptying the tunnel are provided at four points, where the aqueduct comes near the surface. The deep valley of the Harlem River is crossed by an inverted siphon, formed by two shafts and a tunnel under the river. At this point the tunnel is 307 ft. below tide-water level and is reduced to 10.5 ft. in diameter, as the water will pass through under considerable pressure. The total fall from Croton Lake to One Hundred and Thirty-Fifth Street is 25 ft.; from the gate-house to the Central Park Reservoir, 34.4 ft. The average fall in the aqueduct proper is 0.7 ft. per mile.

In building the aqueduct there were 42 shafts sunk, the depth varying from 22 to 420 ft.—the last-named was at the shaft where the tunnel passes under the Harlem. The total cost has been about $23,600,000, to which some additions are still to be made.

In connection with the aqueduct three dams—the Sodom, the Titicus and the Amawalk—are now being built, to form additional storage reservoirs. The yearly supply from the Croton watershed is sufficient for the city, but the storage capacity is not great enough to retain it until it is needed, in the dry season. The system can hardly be considered complete until the great Quaker Bridge Dam is built, when an ample and steady supply at all seasons will be secured.

A PROPOSED SHIP CANAL.

A NEW plan for a ship canal connecting Philadelphia and New York is proposed by Professor Lewis M. Haupt. The proposed line leaves the Delaware at Bordentown, N. J., follows the line of the Delaware & Raritan Canal for 1¾ miles, then runs due north, striking the old canal again north of Trenton and using it for 9⅓ miles more. It then leaves the present canal finally, crosses the divide near Dean's Pond and follows the line of Lawrence Brook to the Raritan River below New Brunswick.

The highest point on the proposed line is 76 ft. above tide-water. The greater part of the canal would be on one level, 50 ft. above tide water, which would be reached by two locks of 25 ft. lift each, at each end of the level. These, with the tide-lock at each entrance, would make six locks in all; the plan makes these 500 ft. long, 60 ft. wide and 20 ft. deep over the sills.

The section proposed for the canal is 20 ft. depth, 90 ft. width at bottom and 150 ft. at the surface. The supply of water along the line is abundant, and there would be no difficulty in keeping the summit level full for any probable traffic and number of lockages. The total distance from Bordentown to the Raritan River is 33¾ miles; the estimated work is about 26,318,000 cub. yds., with about 350,000 cub. yds. of dredging at the terminals. There would be no rock cutting or very expensive work, but 31 bridges over the canal would be needed, as its line crosses 5 railroads and 26 highway roads.

Professor Haupt estimates the total cost at about $12,553,000, excluding right of way.

NEW PUBLICATIONS.

HAND-BOOK OF PASSENGER TRAFFIC AND ACCOUNTS: BY MARSHALL M. KIRKMAN. Chicago; published for the Author.

This is another volume of Mr. Kirkman's well-known series on Railroad Accounts. It treats of the transportation of passengers; of regulations governing the handling of passengers at stations and on trains, and of the ticket accounts of railroads. It also includes a large number of forms for passenger business, based upon long experience of the requirements of a large railroad system. The Author's general plan and method can be best explained by quoting his own preface:

The principles that underlie the operations of carriers are

alike everywhere. Their methods of doing business, however, are never the same. But definite knowledge of one renders it easy to acquire knowledge of another. It is this that makes descriptive books valuable. Through them the student may obtain a glimpse of railroad work generally ; a clew to the labyrinth, without which knowledge cannot be acquired except by a lifetime of laborious practice, and then only disjointedly. This is the object of this book—as it is of the series of books of which it forms a part. I do not write for experts, for men whose minds are made up, but for the young ; for those who still have something to learn ; for those who desire to learn.

Mr. Kirkman does not insist upon uniformity of accounts, believing it to be impracticable and undesirable, on account of the great diversity in local circumstances and the requirements of different railroad lines. He has written his book, therefore, as a hand-book of reference and instruction, not as an absolute system of rules. Viewed in this light, it will be of great service to railroad accountants ; and the numerous forms given will serve very well for models where they cannot be copied or used just as they are given. It covers the field of passenger traffic accounts very thoroughly, and those who are concerned in that subject can hardly read it without gaining some new ideas.

United States Geological Survey. Monograph No. XV ; the Potomac or Younger Mesozoic Flora : by William Morris Fontaine. Part I, Text ; Part II, Plates.

United States Geological Survey. Monograph No. XVI ; the Paleozoic Fishes of North America : by John Strong Newberry.

Bulletins of the United States Geological Survey. No. 54, On the Thermo-Electric Measurement of High Temperatures. No. 55, Report of Work done in the Division of Chemistry and Physics. No. 56, Fossil Wood and Lignite of the Potomac Formation. No. 57, A Geological Reconnaissance in Southern Kansas. Washington ; Government Printing Office.

This group of publications of the United States Geological Survey reaches us too late for much critical comment ; it can only be said now that in general form and execution they are fully up to the high standard generally reached by the Survey. The Bulletin on Thermo-Electric Measurement of High Temperatures is of especial interest.

In this connection it may be noted that a very unwarrantable attack recently made in Congress on the Geological Survey and its methods can best be refuted by the results attained by the Survey and by a simple statement of the work which it has accomplished. It is hardly a secret that this attack has been prompted by interested motives, and that behind it are parties who have planned to absorb for their own profit sources of water supply which would give them a vast water monopoly and consequently the virtual control of a great part of the irrigable lands of the West. These men have found that the work of the Survey on irrigation and the publicity given to it has seriously interfered with their plans ; and they have tried to use Congressional investigation as a means of revenge, or to compel a measure of compliance with their designs. They can hardly be successful, and their total failure is much to be desired.

Eighth Annual Report of the United States Geological Survey to the Secretary of the Interior, 1886–87. Parts I and II : J. W. Powell, Director. Washington ; Government Printing Office.

This report gives a very careful and complete statement of the methods pursued by the Geological Survey in the various departments of its work in the field and in the office, showing how the work is subdivided and the system adopted in carrying it on. Necessarily there are many things to be considered in so extensive a range of subjects as that committed to the charge of the Survey, and system is necessary. The statement of what was done during the year covered by this report shows how great the work is and over how much ground it extends.

Besides the general report and statements, the two volumes include a number of special reports. Among these are monographs on the geology of the Mono Valley and the Lassen Peak in California ; on the Trenton Limestone as a source of Petroleum and Natural Gas ; on the Quicksilver Deposits of the Pacific Slope ; on the Geology of Mount Desert Island, Me., and on the Geographical Distribution of Fossil Plants.

The report shows great progress in the topographical surveys which are carried on under the direction of the Survey, and which are a necessary part and accompaniment of its work. Much progress was also made in the office work connected with these topographical surveys, in the preparation and publication of the maps based upon them.

Preparations were also made for beginning the geologic map of the United States, and much consideration was given to the plan on which this map is to be prepared. The devising of such a plan, which shall be uniform for the whole country, is no easy matter, and requires much care and consideration. The advantages of uniformity can readily be seen, but it is difficult to devise a system by which it can be obtained in such a way as to make the maps of the greatest possible service to those who will use them.

Geological Survey of New Jersey : Final Report of the State Geologist. Volume II, Part I.

Volume I of the State Geologist's Final Report related to the topography and climate ; Volume II treats of the mineralogy, botany and zoölogy of the State, Part I containing lists of the minerals and plants found within its limits. Both the lists are long, for there are few States which have so widely diversified a surface, with a comparatively small area, as New Jersey, and few that have such a variety of minerals. Indeed some localities in the State are famous throughout the scientific world.

The volume is a continuation of the final summing up of the work of the Survey, which is now approaching completion.

Geological Survey of New Jersey : Annual Report of the State Geologist, 1889 : Irving S. Upson, Assistant in Charge. Trenton, N. J. ; State Printers.

The office of State Geologist of New Jersey has not been filled since the death of Professor George H. Cook, but the work has continued under the Assistant in charge, Mr. Irving S. Upson, who has been long connected with it and is thoroughly familiar with Professor Cook's methods and plans. During 1889 the Geological Survey of the State was continued, while in the office the publication and distribution of the first volume of the Final Report was completed, the second volume was prepared for publication, and work begun on the third and fourth volumes.

The work of the New Jersey Geological Survey has always been of a hign order, and has been of great value to the State. Much of this was due to the ability and enthusiasm of Professor Cook, who had charge of it from the beginning, and it is evident that the assistants whom he has trained will not permit the standard set by him to be lowered.

The present report contains special reports or chapters on the Geodetic Survey by Professor E. A. Bowser ; the Archæan Rocks, by Frank L. Nason ; Studies of the Triassic and Trap Rocks ; Drainage in the Pequest and the Passaic Valleys, by George W. Howell ; Water Supply and Artesian Wells, by C. C. Vermeule ; with the statistics relating to the progress and expenses of the Survey, and statistics of the production of iron and zinc ores.

The output of iron ore, it may be noted, was 482,169 tons, an increase over 1888, but a decrease from 1887 and 1886. The

highest point ever reached in the State was in 1882, when 932,762 tons of iron ore were mined. The output of zinc ore in 1889 was 56,154 tons, the largest ever reported, and an increase of 23 per cent. over the previous year.

GRUNDSÄTZE FÜR DEN ABSCHLUSS VON EISENBAHN TARIFCARTELLEN (PRINCIPLES OF THE FORMATION OF RAILROAD RATE AGREEMENTS): BY HERR EMIL RANK, CHIEF OF BUREAU OF THE AUSTRIAN NORTHWESTERN RAILROAD. Vienna, Austria; published by A. Hartleben.

This work is intended, in the first place, as a discussion of the question whether railroad traffic agreements are to be recommended, either from the point of view of the railroads themselves or of the public generally and if this question can be answered in the affirmative, to consider what are the causes of the evils which, it is claimed, traffic agreements have introduced into railroad management. It is intended to consider all those factors which disturb and interfere with the service, and to formulate the principles upon which agreements should be made, basing these on the result of experience. Some consideration is also given to other questions, and especially to that class of agreements which are intended to control the business of districts producing large amounts of traffic.

Some idea of the scope of the book may be gained from the subjects treated in it, which include: Agreements for the Division of Business; Securing Business for Different Routes; Fixing Tariffs under Agreement; Handling of Unbilled Freight; Uniform Division of Profits; Proceeding in Case of Business Disagreements; Right of Mutual Control; Decision of Disputed Questions; Duration of Traffic Agreements; Agreements for Mutual Control of Production Districts.

The subject is treated with the thoroughness which we often find in German works upon this subject, and with much more regard to general principles than we are likely to find in this country. It is well worth the attention of those who are interested in this subject.

SPON'S ENGINEERS' DIARY AND REFERENCE BOOK, FOR ENGINEERS, MACHINISTS, CONTRACTORS AND USERS OF STEAM. London and New York; E. & F. N. Spon.

This has been prepared for English rather than American engineers, the information which it contains being of English trades and markets, the lists of societies English, and the calendars essentially English in their arrangement. About one-quarter of the book is filled with tables of weights, measures, etc., addresses of societies, calendars, reports of markets and similar matter; the remainder is occupied by a calendar having a good space for each day in the year, upon which a memorandum record can be kept. This occupies alternate pages, the intervening pages being given up to advertisements. The diary is convenient; but the book is rather too bulky for daily use.

THE WHITNEY CONTRACTING CHILL: BY JOHN R. WHITNEY, PATENTEE. Philadelphia; published by the Author.

This neat little pamphlet is a brief but forcible—and more forcible because brief—presentation of the merits of the contracting chill and the advantages of its use in casting car-wheels. There has been some discussion of the merits of this device, but the question is, perhaps, one best settled by experience and the actual results obtained from wheels cast in contracting chills. There are certainly many arguments in its favor, and a strong one—which is not mentioned in the pamphlet—is that it has been adopted by wheel-makers of such high standing and long experience as the Messrs. Whitney.

BOOKS RECEIVED.

PROCEEDINGS OF A NATIONAL CONVENTION OF RAILROAD COMMISSIONERS, HELD AT THE OFFICE OF THE INTERSTATE COMMERCE COMMISSION, WASHINGTON, MAY 28 AND 29, 1890. Washington; issued by the Interstate Commerce Commission.

OCCASIONAL PAPERS OF THE INSTITUTION OF CIVIL ENGINEERS. London, England; published by the Institution. The present installment of these papers includes Telephonic Switching, by Charles Henry Wordingham; Building in Earthquake Countries, by John Milne; Deep Water Quays in the Port of Cork, by Philip Barry; Taking the Temperature of the Cylinder Walls of a Steam Engine at Different Depths in the Metal, by Bryan Donkin; Water Works in China and Japan, by J. W. Hart, James Orange and J. H. T. Turner.

A second installment includes papers on the Action of Quicksands, by Wilfrid Airy; Concrete Quarters for Native Staff on Indian Railroads, by Thomas Ker; Reclamation of Lake Aboukir, by H. G. Sheppard; Barry Dock Works, by John Robinson; Lough Erne Drainage, by James Price; three papers on bridges—the Hawkesbury Bridge, by C. O. Burgi; the Dufferin Bridge over the Ganges, by F. T. G. Walton, and the Blackfriars Railroad Bridge, by G. E. W. Cruttwell.

PRACTICAL SANITARY AND ECONOMIC COOKING: BY MRS. MARY HINMAN ABEL. THE LOMB PRIZE ESSAY. Published by the American Public Health Association.

REPORTS FROM THE CONSULS OF THE UNITED STATES TO THE STATE DEPARTMENT. No. 115, APRIL, 1890. Washington; Government Printing Office.

EIGHTEENTH ANNUAL REPORT OF THE PENNSYLVANIA COMPANY, FOR THE YEAR ENDING DECEMBER 31, 1890.

QUARTERLY REPORT OF THE CHIEF OF THE BUREAU OF STATISTICS, TREASURY DEPARTMENT, ON THE IMPORTS, EXPORTS, IMMIGRATION AND NAVIGATION OF THE UNITED STATES, FOR THE THREE MONTHS ENDING MARCH 31, 1890. Washington; Government Printing Office.

THE ECONOMY AND EFFICIENCY OF STEAM HEATING AT ATMOSPHERIC PRESSURE: THE BARNARD VACUUM SYSTEM FOR HEATING BUILDINGS BY STEAM WITHOUT PRESSURE. New York; issued by the Barnard Engineering Company.

THE MAYRHOFER ELECTRO-PNEUMATIC SYSTEM FOR DISTRIBUTING STANDARD TIME. New York; issued by the Electro-Pneumatic Time Company.

EFFICIENCY OF CHAIN BLOCKS: REPORT BY PROFESSOR R. H. THURSTON. Stamford, Conn.; issued by the Yale & Towne Manufacturing Company.

CATALOGUE OF THE CINCINNATI CORRUGATING COMPANY, CORRUGATED AND OTHER SHEET METAL BUILDING MATERIAL. ILLUSTRATED. Piqua, Ohio; issued by the Company.

ABOUT BOOKS AND PERIODICALS.

THE JOURNAL of the Military Service Institution for July has articles on Infantry Battle Tactics, by Captain McClernand; Reform in Army Administration, by Lieutenant-Colonel Lee; Place of the Medical Department, by Lieutenant-Colonel Woodhull; Fifth Corps Ambulance Train in 1864, by Lieutenant-Colonel Drum. There are also a number of translations and reprints of interest, and an historical sketch of the Fourteenth Regiment of Infantry, by Colonel T. M. Anderson.

Among the notable articles in the POPULAR SCIENCE MONTHLY for July are Telpherage in Practical Use, by F. A. Fernald; Meteorites, by Dr. O. W. Huntington; Commercial Geography of South America, by G. G. Chisholm, and Greenland, by Elisée Reclus.

In SCRIBNER'S for July, which is a summer number, Mr. Bruce Price's article on the Suburban House will be found excellent reading. The article of the Citizen Series for the month in on the Right of the Citizen to his own Reputation, and is by E. L. Godkin. Surf and Surf Bathing, by D. Osborne, is hardly a scientific article, but will interest a good many at this season.

Besides the usual excellent assortment of literary matter, BELFORD'S MAGAZINE for July contains an article on Storms and Earthquakes, by Dr. Felix L. Oswald, and one on Sexagesimals and the Origin of Hours and Minutes, by James McCarroll.

The WESTERN ENGINEER for June—published by the Pond Engineering Company—has a very practical article on Steam Boilers for Stationary Power, by William Lowe, which is worth reading.

Reference has heretofore been made to the Lomb prize essays of the American Public Health Association. The prize this year was awarded to an essay on Practical Sanitary and Economic Cooking, as adapted to persons of small and moderate means. The essay was written by Mrs. Mary Hinman Abel, who has fairly earned the prize by a very good and practical treatise, which the Association has just published in book form.

An account of the presentation of portraits of Generals Grant, Sherman and Sheridan to the United States Military Academy at West Point, by Mr. George W. Childs, of Philadelphia, has been issued in a very neat pamphlet form. It is prefaced by some very interesting personal recollections of General Grant by Mr. Childs, who was, as is well known, a very intimate friend of the great commander.

EXPERIMENTS SHOWING THE RATE OF COMBUSTION IN LOCOMOTIVES ON THE BALTIMORE & OHIO RAILROAD.

EXPERIMENTS were made some time ago on the 17-mile grade of the Baltimore & Ohio Railroad by George B. Hazlehurst, now General Superintendent of Motive Power of that line, to show the maximum quantities of coal burned per square foot per hour in the grates of locomotives. The grade referred to begins at Piedmont, and has an ascent of about 117 ft. per mile for 17 miles. This grade is often combined with sharp curves, so that it is a continuous hard pull for the whole distance, and it gives an excellent opportunity of making a test of the quantity of fuel which can be burned in locomotive grates.

One experiment was made with a ten-wheeled engine and a train weighing 352,000 lbs. The running time was just 60 minutes, and the total coal consumed was 3,391 lbs. = 148.1 lbs. per square foot of grate per hour.

A second test was made with the same engine on September 20, 1889. Total weight of train, 380,000 lbs.; running time, 67 minutes; coal consumed, 3,809 lbs.; consumption per square foot of grate per hour, 133.2 lbs.

In both of these tests there was a dry rail and an average steam-pressure of 143¾ lbs. The dimensions of the engine were as follows: Weight in working order, 114,500 lbs.; on driving-wheels, 91,000 lbs.; cylinders, 19 × 24 in.; diameter of driving-wheels, 60 in.; total heating surface, 1,899 sq. ft.; size of grate, 33 × 100 in. = 22.9 sq. ft.; diameter of tubes, 2 in.

Another test, still more remarkable, was made with an American type of engine. The weight of the train was 378,900 lbs.; coal consumed, 5,316 lbs.; coal consumed per square foot of grate per hour, 193.7 lbs.; running time, 59 minutes.

While the last experiment was made the rail was dry; the average steam pressure was 148.1 lbs.; the dimensions of this engine were: Total weight in working order, 107,700 lbs.; weight on driving-wheels, 73,400 lbs.; cylinders, 20 × 24 in.; diameter of driving-wheels, 66 in.; total heating surface, 1,511 sq. ft.; size of grate, 34 × 120 in. = 28.3 sq. ft.

The coal used on these engines was broken gas coal from the Pittsburgh Division of the road, part of it having been in the tender some time. The experiments were made by running the distance from Piedmont to Altamont, about 17 miles. There can be no doubt of the accuracy of the tests, and they show that the maximum rate of combustion in locomotive fire-boxes is considerably greater than is ordinarily supposed. Rankine gives this rate, "with draft produced by a blast-pipe or fan," at 40 to 120 lbs. per square foot per hour. The latter amount has generally been accepted as the maximum quantity burned. Probably 200 lbs. of coal are often burned per square foot per hour in locomotives in this country.

EXPERIMENTS ON THE TEMPERATURE IN LOCOMOTIVE SMOKE-BOXES.

BY REUBEN WELLS.

THE experiments recently made on the Paris, Lyons & Mediterranean Railroad, to determine the variations in economy of locomotive boilers with different lengths of tubes, and which are discussed in an editorial on another page, will give a special interest to some investigations made by Mr. Reuben Wells some years ago on the Jeffersonville, Madison & Indianapolis, of which he was Superintendent of Machinery at that time. Through the courtesy of Mr. Wells we are enabled to give an engraving of the diagrams which he made to represent the results of his investigations. In his experiments the temperature in the smoke-box was taken from a pyrometer every quarter minute, and the steam pressure was taken simultaneously. In the diagrams the spaces between the vertical lines represent minutes and the spaces between the upper horizontal lines represent 20° of temperature. The spaces between the horizontal lines at the lower part of the diagrams represent 10 lbs. of steam pressure per square inch.

The wavy lines at the top represent the temperature observed in the smoke-box of different engines, as will be explained later on, and the steam pressure is shown by similar lines at the lower part of the diagrams.

The experiments were made as follows:

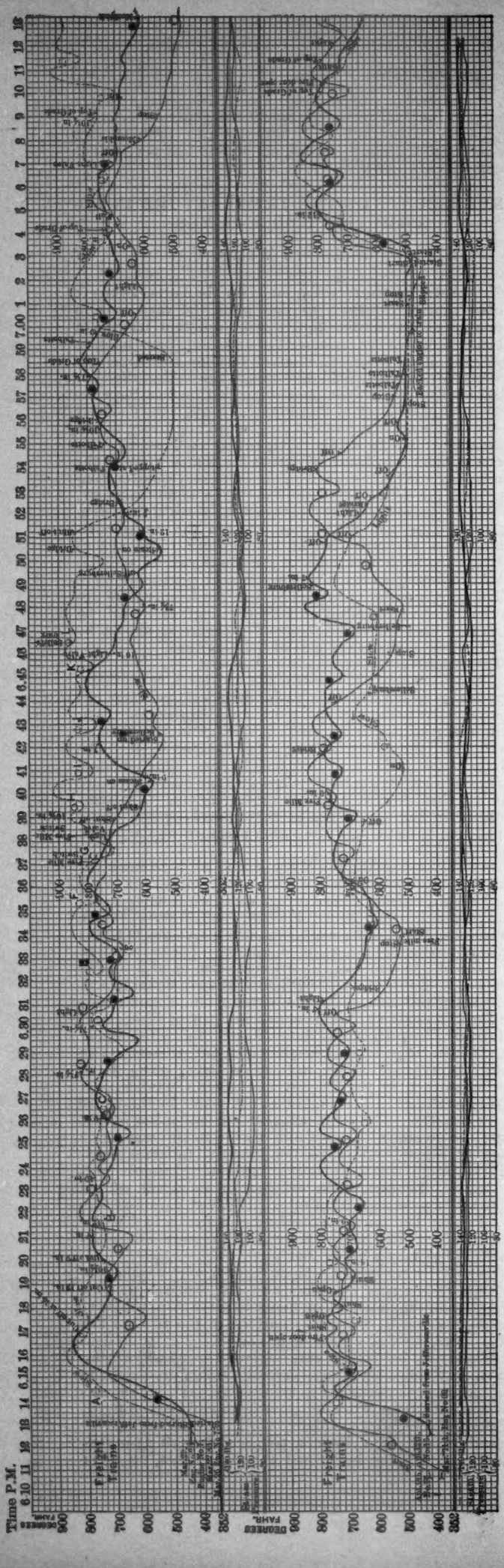
FIRST EXPERIMENT.—Was made on March 22, with engine No. 7, which had 16 × 24-in. cylinders, 5-ft. driving-wheels. The boiler had 114 tubes 2 in. diameter and 11 ft. 2 in. long; 70½ sq. ft. of heating surface in the fire-box and 636⅞ in the tubes, making a total of 707 sq. ft. The train consisted of 26½ loaded freight cars. The average speed was 16 miles per hour. The average steam pressure was 117 lbs. Size of exhaust nozzles, 2 7/16 in. The temperature in the smoke-box is represented by the upper dotted line in fig. 1, and the steam pressure by the dotted line below.

SECOND EXPERIMENT.—Made March 26, with same engine, with 26½ loaded freight cars (three empty cars being rated as two loaded). The average speed while using steam was 17.5 miles per hour; average temperature in the smoke-box, 721° Fahr.; average steam pressure, 114 lbs.; exhaust nozzles, double, 2 1/16 in. diameter. The evaporation on a run of 432 miles and an average train of 28.2 loaded cars was 5.54 lbs. of water per pound of coal, equal to 2.71 lbs. per car per mile. The temperature and steam pressure for this engine are represented in fig. 1 by light lines.

THIRD EXPERIMENT.—Made March 29, with engine No. 28, with 16 × 24-in. cylinders and 5-ft. wheels. The boiler had 153 2-in. tubes, 10 ft. 10 in. long; 90 sq. ft. of heating surface in the fire-box and 830 in the tubes, or a total of 920 sq. ft. The weight of the water in the boiler was 7,000 lbs. The train consisted of 29 loaded freight cars; the average speed while using steam was 14.52 miles per hour. Average temperature in smoke-box, 712°; average steam pressure, 128 lbs. Exhaust nozzles 2 5/16 in. diameter. The evaporation on a run of 432 miles and an average train of 30.71 loaded cars was 6.20 lbs. of water per pound of coal, or equal to 2.17 lbs. per car per mile. The temperature and pressure are represented in fig. 1 by a heavy line.

FOURTH EXPERIMENT.—Made April 9, with engine No. 16, with 17 × 22-in. cylinders and 5-ft. wheels; exhaust nozzles, 3 in. diameter. The boiler had 158 2-in. tubes, 11 ft. long; 96 sq. ft. of heating surface in the fire-box, 868 in the tubes, making a total of 964 sq. ft. The train consisted of 27 loaded freight cars; average speed while using steam, 19.35 miles per hour. Average steam pressure, 129 lbs. Average temperature in smoke-box, 714°. The temperature and pressure are indicated by dotted lines in fig. 2.

FIFTH EXPERIMENT.—Made April 11, with engine No. 30, with 14 × 22-in. cylinders, 5-ft. wheels, and 2½-in. exhaust nozzles. The boiler had 113 2-in. tubes, 10 ft. 11



in. long ; 77¼ sq. ft. of heating surface in the fire-box, 616½ in the tubes, or a total of 694 sq. ft. Weight of water in boiler, 5,600 lbs. The train consisted of 21 loaded freight cars ; the average speed while using steam was 16.5 miles per hour ; average temperature in smoke-box, 739° ; average steam pressure, 124 lbs. The evaporation on a run of 432 miles and an average train of 22.12 loaded cars was 6.07 lbs. of water per pound of coal, or 2.70 lbs. of coal per car per mile. The temperature and pressure are indicated by light lines in fig. 2.

SIXTH EXPERIMENT.—Was made April 12, with engine No. 16, with freight train of 30 loaded cars. Average speed, 16.46 miles per hour ; average temperature in smoke-box, 734° ; average pressure, 129 lbs. The temperature and pressure are indicated by heavy lines in fig. 2.

The circles on the lines or curves which represent the temperature indicate when the furnace door was opened. The solid black circles refer to the dark lines there represented in outline to the light lines, and those which are dotted to the dotted lines, and the figures along the curves indicate the inches of cut-off of the valves.

Taking the experiment of March 22, and it will be seen that in starting from Jeffersonville the temperature in the smoke-box was 360°, and the steam pressure was 126 lbs. Immediately after starting the temperature began to rise, and in four minutes it reached 885°. At *A* the furnace door was opened, but the temperature continued to rise. At *B* it was again opened, and it will be seen that it was succeeded by a fall in temperature, and that was followed by a rise. At *D*, *E*, *F*, *G*, *H*, *I*, *J*, *K* and *L* the furnace door was opened, and in each case it will be seen a fall of temperature followed which was succeeded by a rise. In all the diagrams this sequence is noticeable. It will be seen though, that the furnace door is not usually opened until after the temperature begins to fall, which is perhaps indicated by the steam-gauge. The opening of the door and the consequent admission of cold air carries the temperature still lower until the combustion of the fresh fuel carries it up again.

Where the dotted line in fig. 1 crosses the 51¼ vertical minute line it will be seen that steam was shut off. The temperature was then 840°. It immediately began to fall, and when the engine stopped at 54 minutes it had fallen to 560°, and before starting went as low as 500°. The effect of starting again at 58¼ minutes is again obvious in the rapid rise of temperature. These remarks will apply to all of the diagrams. Our engravings represent only a portion of those which Mr. Wells plotted. The highest temperature shown on the diagrams is 995°, although the portion which we have had engraved shows only 920°.

Mr. Wells also made similar experiments with passenger engines. In these, as might be expected, the variations in the temperature are somewhat more sudden than in the freight engines.

He also experimented with a stationary boiler with natural draft. The changes in the smoke-box temperature were not nearly through so wide a range nor so sudden as in a locomotive boiler. The highest temperature was less than 800°, and the average during 53 minutes was, with coal for fuel, 620°, with 87 lbs. average pressure. While burning wood during 65 minutes the average temperature was 651° and the pressure 87 lbs.

He also made an experiment to show the rate of increase of temperature in the water in boiler, while firing up engine No. 16, with the following results :

Starting fire. ...	60°.		
In 30 minutes,	175°.		
" 55 "	250°.		
" 70 "	275°.		
" 75 "	295°.	Steam commenced to show at the whistle.	
" 85 "	310°.	"	7 lbs.
" 90 "	330°.	"	15 "
" 95 "	340°.	"	22 "
" 100 "	350°.	"	30 "

If the steam pressure had been represented in the diagrams on a larger vertical scale, the relation between it and the temperature in the smoke-box could have been seen more clearly. The experiments are very interesting, and show very clearly the variations which occur in the temperature due to our present imperfect method of firing.

A FRENCH ARMORED CRUISER.

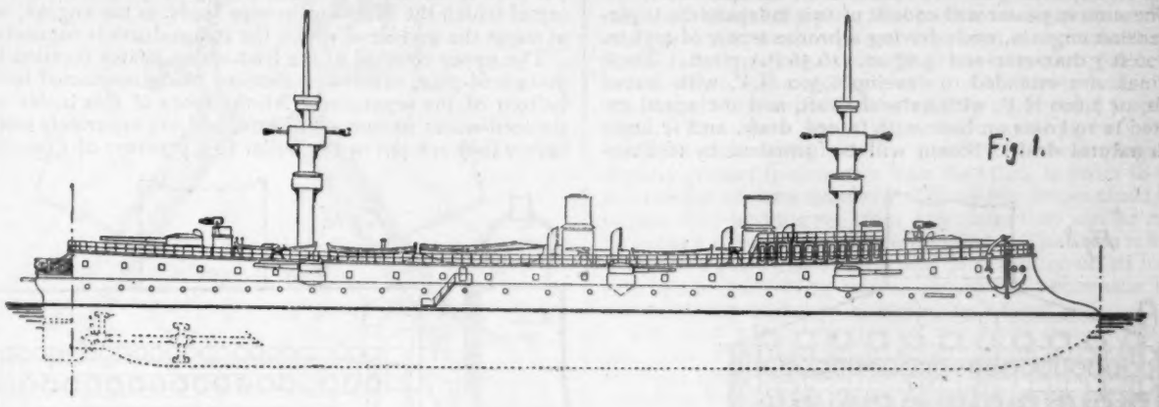
THE accompanying illustrations, from *Le Yacht*, show the plans adopted for the new armored cruiser *Charner*, which is rated as of the second class in the French Navy. These plans have just been completed and the construction of the vessel begun.

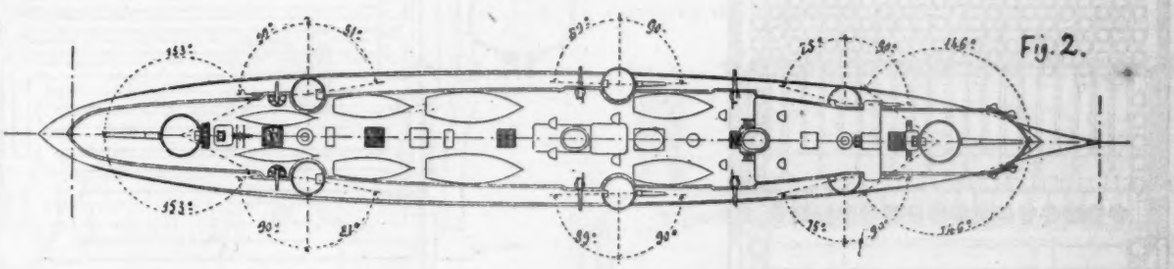
The plans were made by M. Thibaudier, and the principal dimensions of the ship are as follows: Length between perpendiculars, 106.00 m. (347.68 ft.); maximum width, 14.00 m. (45.92 ft.); mean draft of water, 5.84 m. (19.15 ft.). The total displacement is 4,745 tons, the weight being distributed as follows: Hull and armor, 2,858 tons; machinery and boilers, 713 tons; artillery, 278 tons; materials and ammunition, 896 tons.

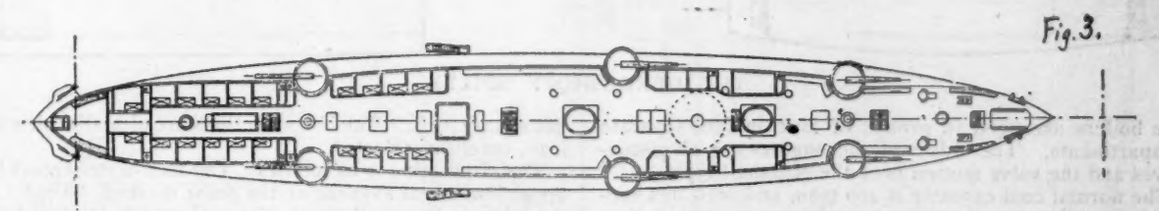
The hull is of steel, the stem being of forged steel and the stern-post of cast steel. The keel is in the form of a double girder and is composed of two plates of steel joined by two angle irons at each side. The plates are spaced 10 cm. (3.93 in.) apart, and the angles are joined together in the form of the letter Z. The space between the two plates is filled in with teak. There are 14 water-tight compartments between the keel and the armored deck, and between the armored deck and the upper deck the ship is divided into six compartments. Provision is made for the use of water ballast.

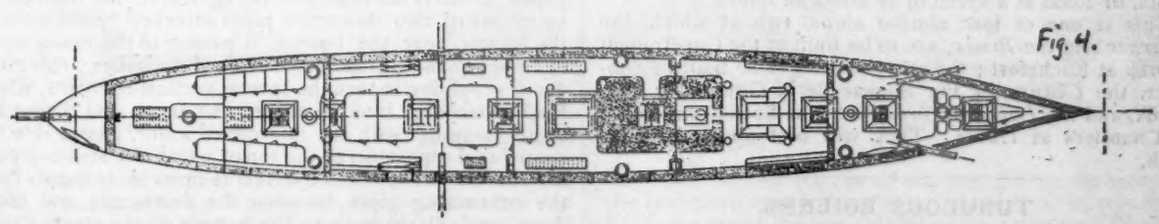
The armored deck is of the turtle-back form, which has been adopted in a number of French vessels. The plates are 5 cm. (1.96 in.) thick in the center, diminishing to 4 cm. (1.57 in.) at the sides.

The armor belt which covers all the vital parts of the ship is 92 mm. (3.64 in.) thick and is bolted to a backing of 18 mm. (0.70 in.), which is considered heavy enough to stop shells loaded with high explosives. The protection in the neighborhood of the water-line is completed by coffer-dams filled with cellulose, which rise to a height of 1.20 m. (3.93 ft.) above the water-line, and which have a thickness of 1.10 m. (3.60 ft.). They rest at the bottom on the armored deck and are shown in fig. 4, given herewith.









ARMORED CRUISER "CHARNER," FOR THE FRENCH NAVY.

Fig. 1 in the accompanying illustrations is an elevation of the ship; fig. 2 a plan of the spar deck; fig. 3 a plan of the lower deck, and fig. 4 of the armored deck.

The armament of this ship consists of two guns of 19 cm. (7.48 in.) caliber and 8.50 m. (27.88 ft.) length; six guns of 11 cm. (4.33 in.) caliber and 4.20 m. (13.77 ft.) length; four rapid-fire guns of 65 mm. (2.53 in.), four rapid-fire guns of 47 mm. (1.85 in.), and six Hotchkiss

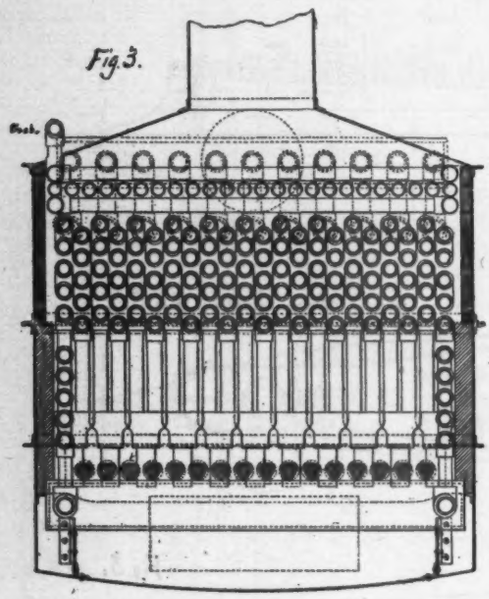
guns of 37 mm. (1.45 in.). There are besides five torpedo tubes. The 19-cm. (7.48 in.) and the 14-cm. (5.51 in.) guns are enclosed in turrets mounted on pivots which descend to the lower deck.

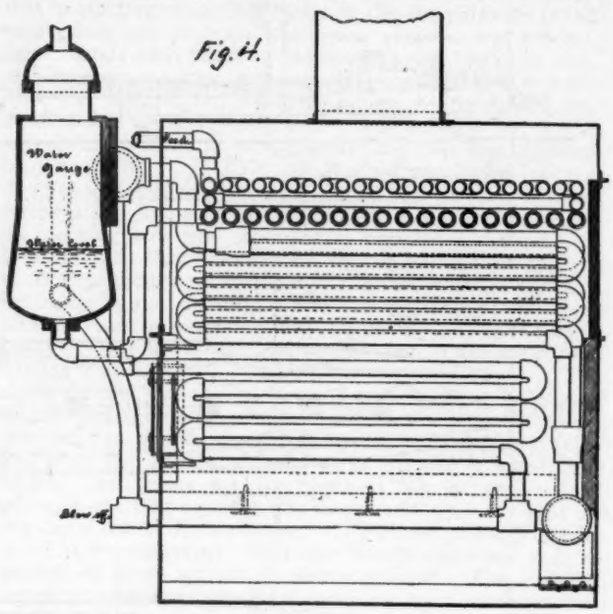
There are two military masts of steel, each composed of an exterior cylinder 1.70 m. (5.57 ft.) in diameter and an interior cylinder 0.50 m. (1.64 ft.) in diameter, carrying above a light mast for signals. Between the inner and the outer cylinders is a double ladder for ascent and descent. Each mast is supplied with three platforms, the lower one serving as a lookout, while the second is a small turret carrying a rapid-fire gun of 47 mm. (1.85 in.) caliber; the third platform is a redoubt for riflemen. The other two 47-mm. guns are mounted on the spar-deck.

The motive power will consist of two independent triple-expansion engines, each driving a bronze screw of 4.35 m. (14.26 ft.) diameter and 5.05 m. (16.56 ft.) pitch. These engines are intended to develop 8,300 H.P. with forced draft, or 7,600 H.P. with natural draft, and the speed expected is 19 knots an hour with forced draft, and 17 knots with natural draft. Steam will be furnished by 16 Belleville boilers arranged in groups of four, in four separate compartments. The valves of the engines are all piston-valves and the valve motion is of the Marshall type.

The normal coal capacity is 400 tons, and with this supply the cruising range will be 3,000 knots at a speed of 12 knots, or 4,000 at a speed of 10 knots an hour.

This is one of four similar ships, two of which, the *Charner* and the *Bruix*, are to be built at the Government Works at Rochefort; the other two are to be built by contract, the *Chanzy* by the Société de la Gironde at Bordeaux, and the *Latouche-Treville* by the Société des Forge et Chantiers at Havre. They will cost about $900,000 each.





THE HERRESHOFF BOILER.

TUBULOUS BOILERS.

(Paper read by Assistant Engineer S. H. Leonard, U. S. N., before the American Society of Naval Engineers, and published in the *Journal* of the Society.)

(*Concluded from page* 321.)

THE HERRESHOFF BOILER.

THIS boiler, shown in figs. 3 and 4, consists of a number of vertical elements, each composed of horizontal tubes, with right and left-hand threads, and connected by return bends. Two adjacent elements are connected at the back and lower ends by short vertical tubes to a Y-piece, which has a short connection to a mud-drum situated below the grate bars. At the upper ends the same elements are similarly connected to a steam-drum situated just in front of the boiler casing. At each side of the grate there is an element having a connection to the steam-drum, and another to the feed-water pipe near the mud-drum. These side elements and the vertical connecting pipes to the mud-drum serve like water-legs to protect the boiler casing from the intense heat of the fire. Above the boiler proper and entirely within the casing there are three horizontal elements forming a practically continuous pipe, the tubes of which are connected to each other as in the vertical elements. These elements serve as a feed-water heater and also protect the top of the casing by reducing the temperature of the gases of combustion. In front and at the upper part of the boiler is the centrifugal separator, from the top of which the main steam pipe leads to the engine, and at about the middle of which the steam-drum is connected.

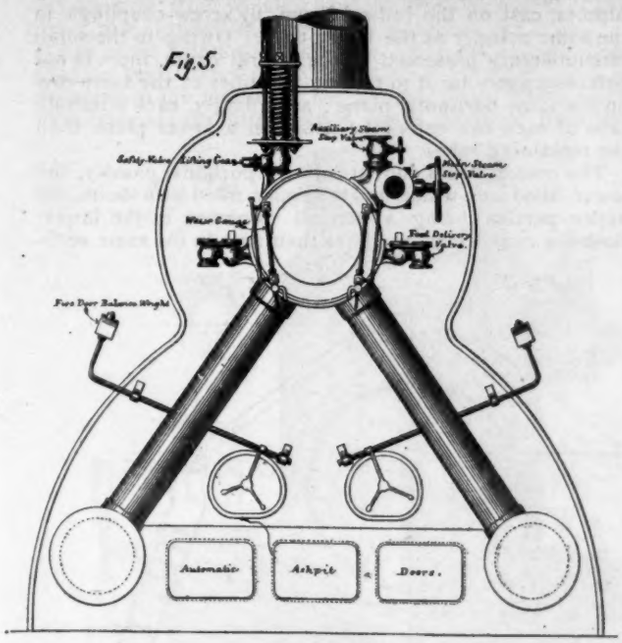
The upper element of the feed-water heater receives the main feed-pipe, the lower element being connected to the bottom of the separator. All the tubes of this boiler and the feed-water heater are of iron, and are separately tested before they are put in the boiler to a pressure of 1,000 lbs. per square inch. The U-connections are of malleable cast-iron, carefully selected.

The circulation is as follows: The feed-water enters the upper horizontal element at the point marked "Feed" on the plate; forced through these elements by the feed-pump, it enters the bottom of the separator, and from there, by means of two downcast pipes attached to the sides of the former near the bottom, it passes to the lower water chamber or mud-drum at the back of the boiler; this mud-drum supplying in turn the several vertical elements, which finally discharge into the side of the drum, and thence the steam, together with any intermixed water, passes into the centrifugal separator, to the top of which the steam-pipe is attached. The lower side elements draw their supply from the connecting pipes between the downcasts and mud-drum, and discharge into the bottom of the steam-drum, there meeting the discharge from the vertical elements. This design of boiler looks toward a complete, or nearly complete, conversion of the water into steam before it reaches the steam-drum. The object of this later design is to produce a boiler which will not require as close attention to the feed supply as did the original Herreshoff coil boiler.

THE THORNYCROFT BOILER.

This boiler, shown in figs. 5, 6 and 7, consists of a horizontal drum or separator at the top, placed longitudinally over the center of the grate; two smaller horizontal cylinders on either side of the grate, a number of steam gener-

ating tubes, connecting the upper part of the circumference of the smaller cylinders with that of the separator, and of two downcast pipes outside of the furnace, connecting the separator with the wing cylinders, these pipes being for the sole purpose of supplying water to the wing cylinders. The greater number of the generating tubes

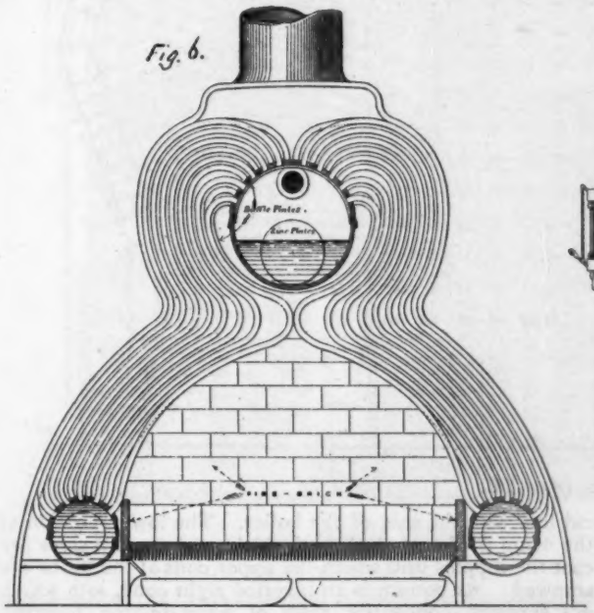


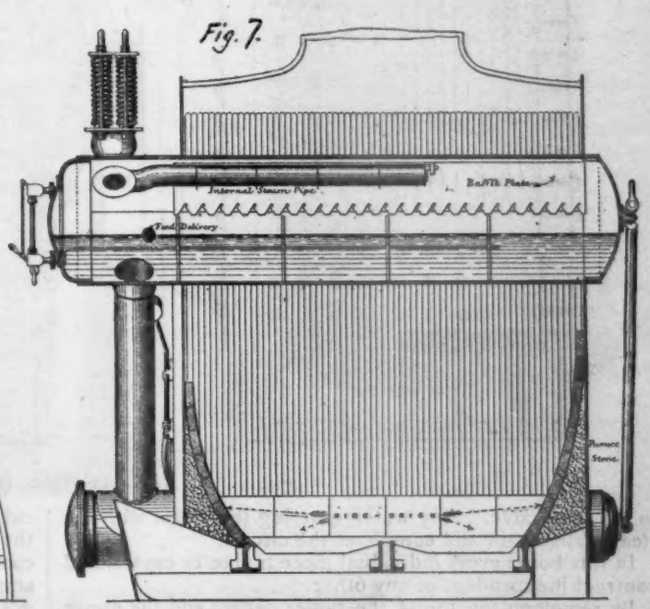
to the top of the drum is placed the dry-pipe leading to the stop-valve on the front of the boiler. The wing cylinders are protected from the direct heat of the furnace by the fire-bricks, which form the sides of the grate. In case of a tube giving out, it can be readily plugged from the inside of the drums, and as the heating surface is relatively large in this type of boiler, quite a number of the tubes could be so treated without seriously impairing the efficiency of the boiler.

THE TOWNE BOILER.

This boiler is of rectangular box form, as shown in figs. 8 and 9. It is provided with a steam-drum or separator, which is connected with the boiler proper at the top by means of downcast pipes. The horizontal tubes are screwed into the drum, as shown, and expanded in the tube sheets. These latter are bent or inclined to meet the generating tubes, which make an angle of 30° with the vertical. The spacing of these tubes will be readily understood from the plate. The screw plugs in the boiler shell permit of any defective tube being readily removed. These plugs are slightly greater in diameter than the tubes, in order to permit the use of an expander. The plugs are so made that in case they become set from any cause they can be readily broken if necessary to remove them. The drum is fitted with baffle-plates, as shown, and is protected on its lower side by the generating tubes, and on its upper side by a coil of piping acting as a feed-water heater.

The feed enters the front of the boiler casing, near its top, and after passing through the feed-heating coil, emerges again and enters the front head of the separator, below its water level. From here, by means of downcast pipes, the water passes to the bottom of the boiler, thereby supplying the generating tubes, which in turn carry it to





THE THORNYCROFT BOILER.

are arranged as shown in continuous full lines in fig. 7, those in full lines in fig. 6 being only the groups at each end of the Boiler, which are so arranged for the purpose of protecting the ends of the casing. The separation of the steam and water is effected by a semicircular baffle-plate placed inside the separator at its upper end, and upon this plate the steam and its contained water is discharged from the generating tubes.

The circulation is as follows: The feed-water enters the lower part of the separator at the front end of the boiler, thence passing to the downcast pipes at the back, it is led to the wing cylinders, which in turn supply the generating tubes. These latter discharge into the upper semi-circumference of the steam-drum or separator, the steam and water impinging directly upon the curved baffle-plate previously mentioned. Directly beneath this baffle-plate and close to the top of the box section again, and thence, by means of the horizontal connecting tubes, it passes to the separator. From the top of the separator the steam passes to the main steam pipe, after passing through a baffle-plate.

THE WARD BOILER.

This boiler, in its general form, is a vertical cylinder, as shown in fig. 11. Radiating from either side of a central vertical drum, is a row of vertical steel columns, placed at an angle of 180° apart; these columns on one side of the drum rest on a horizontal manifold, their upper ends being closed; the vertical columns on the opposite side are connected to horizontal manifolds at top and bottom. These three manifolds are connected to the central drum at their inner ends.

In a plane, slightly inclined to the horizontal, are a large

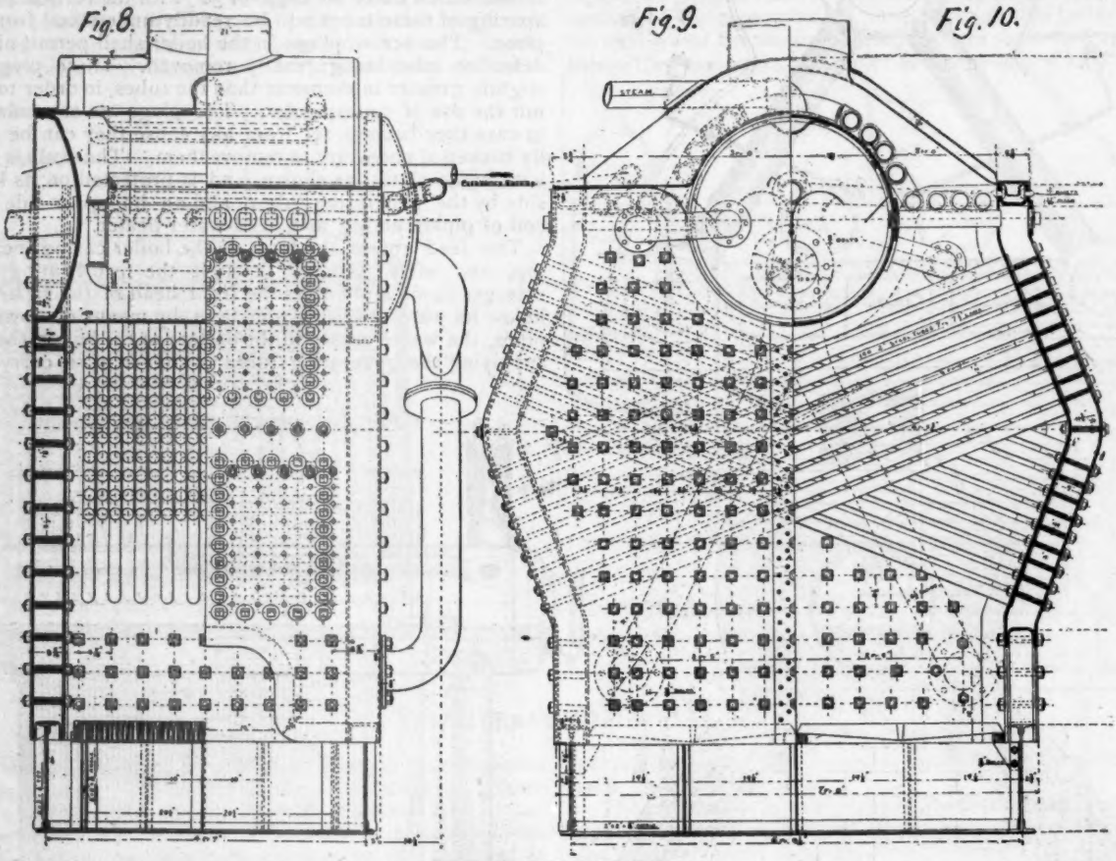
number of concentric tubes, each completing a semi-circumference; there are the same number of concentric sections or nests of these tubes as there are vertical water columns. The tubes are secured to the vertical columns ly means of steel bushings, with right and left-hand threads and thus a defective tube can be readily removed.

The feed-water enters the base of the vertical drum, and is conducted by an internal pipe (having an inverted "rose" on its end) to about the water level in the boiler; from here it passes down the drum to supply the horizontal manifolds *C* and *P*; from manifold *P*, water passes to the vertical water columns *E E E*, which in turn supply the horizontal tubes; these latter discharge into the vertical columns *H H H*, and, together with the steam formed in these columns, flow to the upper manifold *I*, and thence to the upper part of the central drum; the steam, after passing through a baffle-plate, enters the dry-pipe *J* leading to the stop-valve. Any water entering the drum with the steam falls again and completes the circuit.

In this boiler every individual piece is free to expand and contract independent of any other.

By removing the top of the boiler casing and the upper manifold *I*, any of the nests of tubes may be *raised* out of the jacket for examination or repairs.

Fig. 8. Fig. 9. Fig. 10.



THE TOWNE BOILER.

THE WARD LAUNCH BOILER.

This boiler, shown in fig. 12, has recently been fitted to some of our navy launches, and is also in general form a vertical cylinder, but is radically different in its general arrangement of pipes from that of the large Ward boiler.

From a horizontal annular manifold, a double row of small water tubes rises vertical 3 ft. to 6 ft., according to the size of the boiler, and then taking an easy sweep of 90°, enters a central drum. In order to form the furnace door, a rectangular, hollow, vertical projection is cast upon the upper semi-circumference of the manifold. The interior of this projection is in connection with the interior of the manifold and contains water. Upon the top of the projection for the furnace door, and upon the upper surface of the manifold, nipples are placed alternately on different diameters, so that the nipples of one row come opposite the spaces between the nipples of the other row. Into these nipples the lower ends of the two rows of vertical tubes, forming the sides of the furnace, are secured by screw-couplings. The upper ends of the tubes are secured into nipples, cast on the central drum, by screw-couplings, in the same manner as the lower ends. Owing to the small circumference presented by the central drum, there is not sufficient space for it to receive the tubes of the same row on the same horizontal plane; accordingly, each alternate tube of each row enters the drum on a lower plane than the remaining tubes.

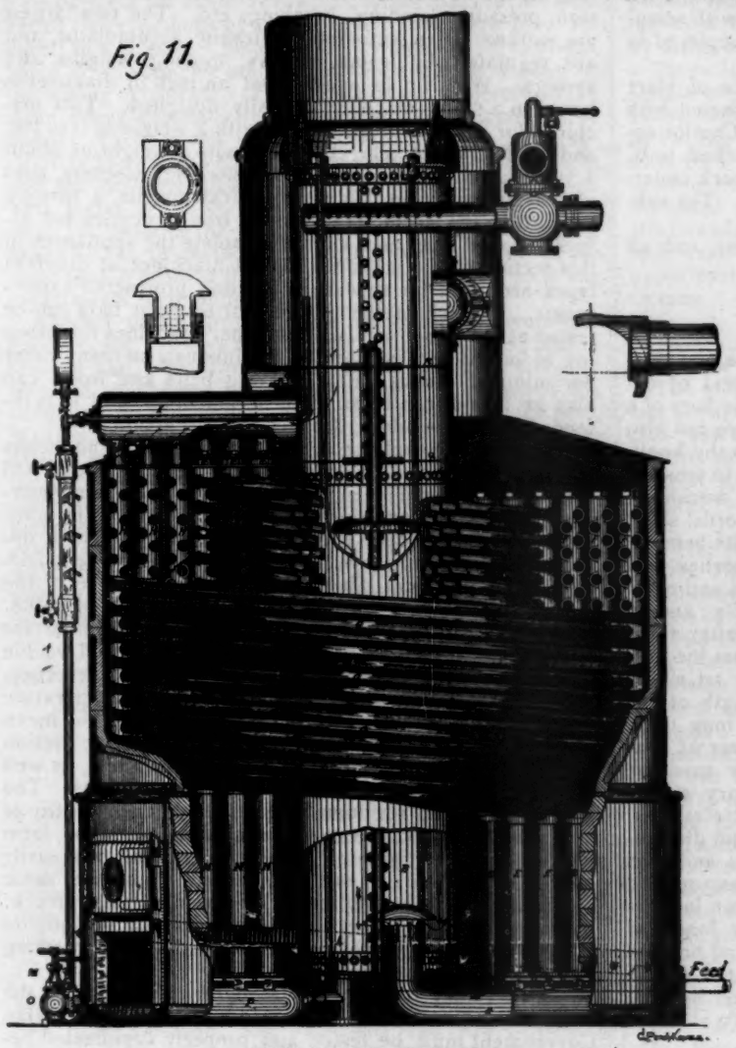
The central drum consists of two portions, namely, the lower, filled with water, and the upper, filled with steam, the upper portion being a vertical extension of the lower. Both are cylindrical, and have their axes in the same vertical line with the axis of the boiler. The lower portion of the drum is of cast steel, $\frac{5}{8}$ in. thick, and upon its sides are cast the nipples into which the upper ends of the tubes are screwed. Its bottom is an inverted right cone, into which are screwed concentric rows of wrought-iron hanging tubes. The open top of these hanging tubes has a wrought-iron plug, perforated with two holes, fitted tightly into it and held in position by friction. Each of these perforations is fitted with a seamless brass tube open at both ends. One of the tubes extends downward into the hanging tube to within one inch of the bottom of the latter; the other extends upward 6 in. on its slant height above the bottom of the lower portion of the drum.

The two brass tubes are parallel with the hanging tube, to which they are attached. The plug acts as tube-plate for both.

The lower portion of the drum has an inclined partition carried entirely around it, partitioning off an annular pocket of triangular cross-section. This partition joins the vertical sides of the drum, just below the entrance of the outside row of tubes forming the sides of the furnace, and divides the water in the lower portion of the drum into two separate portions.

The feed enters a conduit formed by a semicircular lip turned over at the upper end of the partition, and from which it is delivered into the annular triangular cross-sectioned space formed by the partition and sides of the lower portion of the drum. From this space the water descends the *outer* row of tubes to the horizontal manifold or base-ring, from which it ascends again by means of the *inner* row of tubes into the lower portion of the drum.

The water enters the brass tube inside the wrought-iron hanging tube from the lower portion of the drum, and is delivered at the bottom of the hanging tube. The water then descends the latter, and is finally delivered from the upper end of the brass tube that is above the hanging tube into the lower portion of the drum.



THE WARD BOILER.

The small quantity of water in the tubes relatively to their heating surface causes the circulation in this boiler to be very rapid.

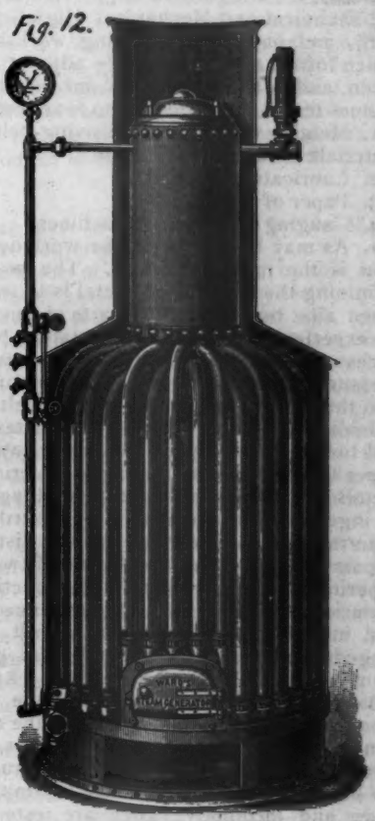
The discussion on this paper showed a general opinion in favor of some form of tubulous boiler. Admitting the necessity of greater care and watchfulness and of frequent cleaning, it was still considered that the demand for higher pressures could be met by this class of boiler, and that the advantages in the diminished space and weight were undoubted. One member advocated the claims of the Belleville boiler, saying that it had hardly received fair treatment in the tests made.

It may be noted here that the Ward boiler has been adopted for the coast defense ship *Monterey*, now under construction at San Francisco, which is to have four of these boilers.

THE GERMAN TESTING STATION AT CHARLOTTENBURG.

(From *Industries*.)

SOME articles have been written lately respecting the various fuel-testing stations which have been established in Germany and elsewhere, and urging their adoption in England. With the penetration and scientific insight that distinguishes them, the Germans were among the first to perceive that the introduction of steam and machinery had revolutionized industry, and that it was, therefore, essential that the working conditions of a boiler, for instance, should be as perfect as possible. The relations between the steam and the combustible generating it having been determined, it has for many years been within the power of every coal consumer in Germany to have his fuel consumption tested at a small cost, and its heating value ascertained. And of late a fresh step has been taken. The Germans have succeeded in arranging for daily tests, on a large scale and by accurate scientific methods, of the strength and quality of iron, wood, steel, paper, oil, etc.—in short, of all materials used in machinery and construction.



THE WARD LAUNCH BOILER.

About six years ago a testing station was established at Charlottenburg, under the auspices of the Prussian Government. The institution has been organized on a strictly scientific and commercial basis. A series of instruments have been devised, chiefly by the officials who conduct the tests, for carrying the trials out as perfectly as possible;

and a fixed scale of charges has been drawn up. Any manufacturer, wishing to have a product of his mill or factory tested, is supplied with a tariff of prices, a list of the different methods by which the article specified can be tested, and precise instructions regarding the proper size of the samples to be sent in. Although the establishment is still in its infancy, it will be seen at a glance how important a place it may hereafter occupy in commercial industry. All disputed questions between buyer and seller as to strength and quality of goods delivered can be settled at once, and the interests of both equally protected by an appeal to the authorities at Charlottenburg. A still more critical function is there performed, by testing with scientific precision the strength of the materials employed in bridges, buildings, etc.

The institution is under the superintendence of Herr Martens, a distinguished engineer. It is connected with the Technical and Mechanical High School at Charlottenburg, and has an engineering workshop attached to it, which forms an indispensable adjunct to the work undertaken, and a training school for the students. The substances tested are divided into four sections:

1. Metals, wood, ropes, driving-belts, chains, and all materials used in construction.
2. Lubricating oils.
3. Paper of all kinds.
4. Gauging and testing machines.

1. As may be supposed, the work done in the first division is the most important. The usual method of determining the strength of metal is to test sample bars of a given size, but the actual parts of any structure can also be experimented upon. The station possesses the appliances necessary to determine the resistance to tension, pressure, percussion, bending, twisting and buckling; also the tensile strength of leather belts and cords, sheet iron and corrugated plates. Wire is tested for its bending and twisting capacity, oil for its lubricating properties, and paper for strength and quality of material. Iron and other metals are also tested by weights falling vertically; and by an ingenious arrangement, to be described hereafter, these experiments can be carried out at a distance from the testing station. The tests applied are of two kinds: 1st, single experiments upon the tensile and ductile strength of the material; 2d, repeated trials continued for a long time, and intended more especially to test for power of prolonged resistance. The metal bars generally used are from 1¼ in. in diameter upward. An ordinary simple test comprises: Determination of the limit of elasticity, breaking weight, the elongation of the metal, and diminution of area after fracture. Sleepers, girders and iron columns are tested for resistance to sudden pressure, and the limits of elasticity obtained. Samples of iron for carriage and locomotive axles are tested, under load and while revolving. The hardness of sheet iron and buckled plates, the strength of telegraph wires, and the tensile strength of wood, driving-belts, steel, iron and hempen ropes are also carefully proved and tested. To all these operations a regular tariff of prices is attached.

A complete trial of cast iron comprises the following processes: 1. Three separate tests of the resistance of the metal to bending. The size of the bars experimented on must be 3 ft. 7 in. × 1¼ in. × 1¼ in. 2. Tension and torsion tests, without determining the limit of elasticity, upon some of the bars already tested for bending. 3. Six pressure tests, made upon cubes 1¼ in. side, cut from bars already tested.

In even the smallest experiments it is desirable to test not less than five bars of a certain prescribed size, as the average quality of the metal cannot be determined from fewer experiments. If special strength and solidity are required more elaborate trials are necessary. By these tests two important points are ascertained: 1. The original quality of the materials used, and (2) the changes they undergo in the process of manufacture. The size of the bars experimented upon is a matter of much importance. The instruments for carrying out the tests are of course adapted for working upon material of a certain size, and are with difficulty adjusted differently. Tools for separating the portion to be tested from the rest of the metal are provided in the workshop of the station. It is so necessary that this portion should really represent the average quality of the material that the authorities prefer to have the metal sent in the rough, and to cut the test pieces from it themselves. The proper experiments for determining the limit of elasticity can only be carried out with bars of the standard size.

Testing the materials used in construction and in machinery is at present the most important function undertaken at Charlottenburg, and a large number of instruments are used for this purpose. Four machines, having a capacity respectively of 98 tons, 49 tons, 39 tons, and 1 ton, are employed to test the resistance of metals to tension, pressure, bending, breaking, etc. The two largest are worked by an automatic hydraulic accumulator, and are regulated by levers, screws, moving weights and springs. Wire up to one-third of an inch in diameter is tested in a small machine specially designed. Two machines for vertical pressure, one with a weight of 110 lbs. and a fall of 14 ft. 9 in., the other with a weight of about 1,350 lbs. and a fall of 32 ft., are used for sleepers, tires of wheels and axles. Measuring instruments, a furnace for testing the elasticity of red-hot iron, crucibles for alloys and cast iron, and a forge complete the appliances in this section of the station. Eleven machines of different types are used for repeated and long protracted experiments. In each of them from four to eight bars can be tested at the same time, and in other machines the bending of loaded bars is repeated continuously so many times per minute. Ropes, cords, driving belts and wood can also be tested in almost all these machines, and it is intended shortly to add appliances for percussion.

2. These, although the most important, are by no means the only experiments undertaken by the institution. Oil for lubricating machines is analyzed and tested under ordinary working conditions. Nothing, perhaps, is more essential to the proper driving of machinery than to determine the quality of the materials used to prevent friction. The chemical laboratory, which forms one of the chief departments of the station, here becomes of value. The oil is subjected to 12 tests. The most important are the determination of the specific gravity and visible properties of the oil, as color, transparency, iridescence, taste and smell; its power of liquefaction at a temperature varying from 68° Fahr. to 302° Fahr.—for this the mean of 10 experiments is taken. The coefficient of friction for a given speed and pressure is also ascertained, as well as the point at which the oil congeals and burns. The boiling-point, the residuum after boiling, the quantity of acid contained, and the chemical analysis of the oil form part of the investigation. These experiments are easily and accurately carried out with various appliances, some of them automatic. Where a new vein of oil is struck, and it is desirable before working it to know the quality of the oil, the value of this systematic and scientific testing can scarcely be overrated.

3. Paper may be, and is, frequently subjected to the same exhaustive tests. All paper supplied to the Prussian Government must be tested and properly certificated before it is accepted; the value of other paper is ascertained at the wish of the buyer or seller. For these experiments the paper is divided into two sections, comprising (1) strength of texture, and (2) quality of material used. Each section is subdivided respectively into six and four classes, and every kind of official paper must pass a certain standard prescribed by Government. In Section 1 the strength of the paper is tested according to a theoretical quantity called the "tearing weight." The weight required to break the paper is first ascertained, and then reckoned in so many thousand feet of paper of the same width. Thus the tearing weight of a first-class paper will generally be about 5,466 yards of paper. The paper is also tested for its elasticity, resistance to creasing and crumpling, material of which it is composed, and especially for any admixture of mechanical wood-pulp, which is rigidly excluded from the composition of all good paper. The tests usually applied to a paper are: Determination of its tearing weight and elasticity, of its resistance to friction and crumpling, quantity of ash left after combustion, chemical examination to detect wood-pulp if present, microscopical examination of the fibers and other materials

in the paper, and chemical analysis of the coloring matter, acids, chloride, etc., in the paper and sizing. The shape and quantity of paper to be sent in is fixed by the authorities, though it is not so strongly insisted on as in the case of metals.

4. A fourth branch of the institution, which has not yet assumed large proportions, is that of testing the instruments and appliances used to prove the strength of metal. These machines are either completely tested in all their parts, or the accuracy of certain important sections, as weights, scales of measurement, levers, etc., are carefully verified. Attached to this branch of the establishment is a department for enabling manufacturers to make practical use of those methods of testing which have here been reduced to a science. Small copper cylinders 2 in. in height and ¾ in. in diameter are sent, if desired, with a copy of the testing certificate. The cylinders are subjected to the same heavy vertically falling weight as the metal to be tested. Their power of resistance to pressure being accurately known, the effect produced on them is calculated, and the resisting strength of the iron deduced from it. This forms a simple and convenient method of testing iron. It obviates the difficulty and expense of conveying heavy blocks of metal to the testing station, while at the same time it ensures the same scientific accuracy as in the experiments there undertaken.

Another useful branch of the institution is devoted to photography. Views are taken of exploded boilers, broken bridges and other iron structures, and of large pieces of wrecked machinery, and afford a valuable record of the condition of the iron at the actual moment of fracture. Many of these interesting photographs were shown at the section allotted to the Charlottenburg Testing Station in the Berlin Exhibition of 1889. A valuable and instructive collection of objects was also exhibited, comprising fragments of iron from exploded boilers, the exact point in a girder where it had given way, the piece of defective metal which had caused the collapse of a building, together with models or photographs of the various apparatus and appliances used in the testing operations of the station.

INTEROCEANIC COMMUNICATION BY WAY OF THE AMERICAN ISTHMUS.

By Lieutenant Henry H. Barroll, U.S.N.

(*Concluded from page* 300.)

XXVI.—THE NICARAGUA ROUTE.

The canal route extends from Greytown, by way of the valley of the San Juan, to Lake Nicaragua, and passing through that lake, thence cutting through the Western divide, and by the valley of the Rio Grande to Brito, where an artificial harbor must be constructed.

The scheme is that of a lock canal having for its summit level Lake Nicaragua. By constructing dams across the San Juan, Deseado, San Francisco and Rio Grande, a system of free navigation is given, all of which is at an elevation of between 106 and 110 ft. above sea-level.

Starting from Greytown, the canal line extends westward through an alluvial soil capable of being dredged. At 10 miles from Greytown is situated Lock No. 1, which has a lift of 31 ft.

Two miles farther westward are situated Locks Nos. 2 and 3, or a double lock, having a combined lift of 75 ft., the highest of these locks opening into the Deseado Basin.

The Deseado Basin is formed among the natural hills by a dam thrown across the Deseado River, by way of which stream the surplus water is carried off.

This basin affords 4.25 miles of free navigation, when a cut of about 2.75 miles through rock is necessary, this being the Eastern divide. This is the deepest cutting on the whole line, and is, on the average, about 135 ft. to the canal bottom, the depth running between 0 and 185 ft.

Once through the Eastern divide, the line enters the San Francisco basin, where 12 miles additional free navigation is encountered to Ochoa, where will be situated the dam across the San Juan River.

This will be about 1,200 ft. along the crest and raise the water 50 ft., while from the lowest part of the foundation to the crest of the dam is about 65 ft.

This dam raises the waters of the San Juan River to 106 ft. above sea-level, the same height as that obtained by the combined lift of locks Nos. 1, 2 and 3. From here to Fort San Carlos, where the San Juan debouches from the lake, is a distance of 64.5 miles. Allowing ¾ in. to the mile as the natural rise of the San Juan in this distance, gives 4 ft. additional elevation at this point.

From Fort San Carlos across the lake, is a distance of 56.5 miles. On the western side of the lake the canal enters a cut of slight depth in earth and rock for nine miles, passing through the Western divide, and issues thence into the Tola Basin, with 5.5 miles free navigation obtained by damming the Rio Grande.

There is from the Tola Basin to the Pacific a perfectly simple way of moving down to the sea-level through the valley of the Rio Grande; but Mr. Menocal has found that by cutting slightly to one side, the line enters a bed of solid rock, and here two locks, in close proximity, will be hewn out of the solid rock, giving a descent of 85 ft., and the canal proceeds in excavation, down the valley of the Rio Grande a distance of two miles, to the last lock—a tidal lock having 30 ft. lift—from which the canal enters the upper part of the harbor of Brito, 1½ miles from the Pacific Ocean.

This is a superior route to that presented by Mr. Menocal before the Paris Conference, in 1879.

The principal question of communication by this route has always been that of passing the Western divide. The San Juan River, forming the only outlet of the lake, leaves it at its southeast extremity, at which point the lake shore nearest approaches the Caribbean Sea. The San Juan Valley, then, shows the lowest level on this side of the lake.

There were eight different proposed routes from the lake to the Pacific.* Commander Lull, by surveys in 1872, eliminated several of these, and limited the field of investigation to those in the vicinity of the Rio del Medio and the Rio Lajas.

It then became apparent that on the Rio Lajas route, provision must be made for the waters of the Guscoyal, Espinal and Rio Grande, as well as eight smaller streams; while only two small ones, the Del Medio and Chocolata, need be provided for on the Medio route.

It was also found that the route by the Del Medio was some 1½ miles shorter, but that the dividing ridge by way of the Medio was 90 ft. higher than that by way of the Rio Lajas.

In 1880 the Secretary of the Navy directed Civil Engineer Menocal to further investigate this locality, in order to determine the practicability of diverting the Rio Grande (a Pacific slope river) into Lake Nicaragua, and thus remove the greatest objection to the Lajas route.

Mr. Menocal met with success in his investigations. Colonel Childs, who had made a study of this route in 1851, had advocated taking the Rio Grande into the canal. Mr. Menocal found that it discharged, at its highest stages, 10,000 cub. ft. of water per second. It was, therefore, out of the question to admit this into the canal.

He proposed a dam across the Rio Grande at a point called El Carmen, about 3,000 ft. from the line of the canal, which would raise the waters of the river sufficiently to allow them to discharge by an artificial channel into a small stream known as the Juan d'Avila, and thence into the Lajas, by which its waters would be emptied into Lake Nicaragua instead of into the Pacific.

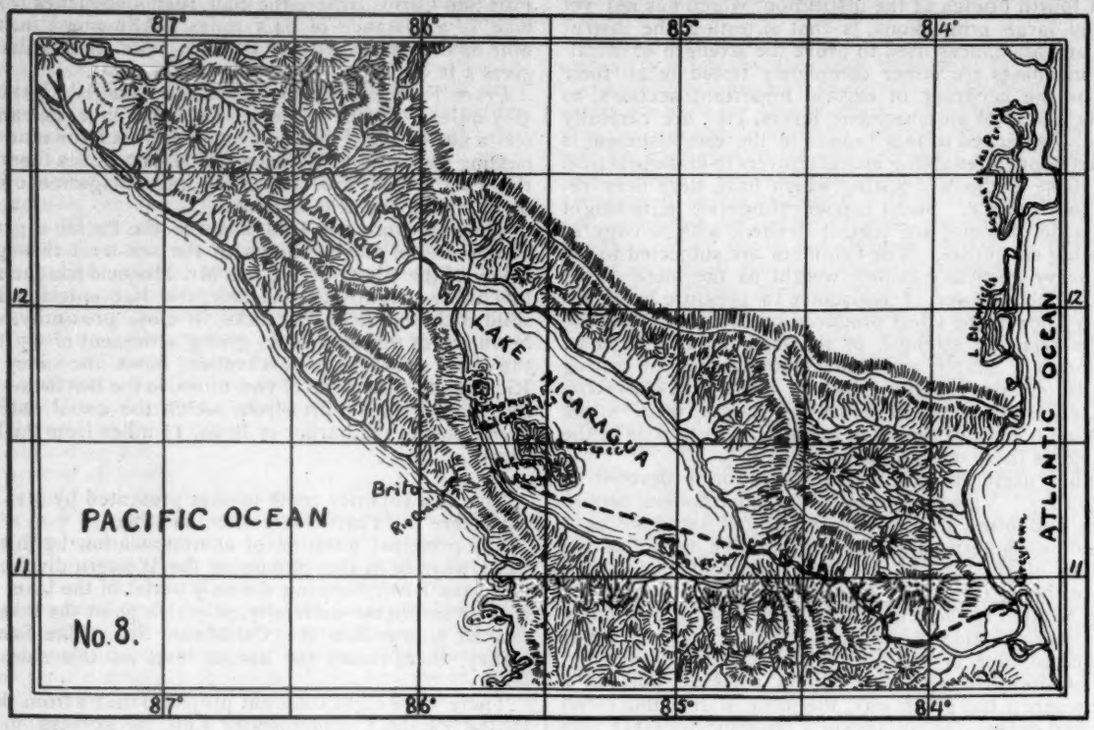
Having established the practicability of diverting the Rio Grande, Mr. Menocal examined the narrow valley occupied by that river below the projected dam, having in view the re-location of the canal-line, so as to utilize the channel, avoiding, as much as possible, the hills on each side, and enlarging the radii of its curves as much as the topography of the country would allow.

This re-location of the line of the western section of the canal made a much more favorable route. By this change, which was completed in 1885, Mr. Menocal esti-

* See pages 203 and 204 in the May number of the Journal.

mates a saving of $16,000,000 on a previously estimated cost of $52,000,000.

For the next two and one half years surveying was constantly going on, to establish absolutely this re-located line, and the canal-route, as now located, undoubtedly occupies the lowest existing depression between North and South America.



The accompanying illustrations show, in No. 8, a general map of the canal and isthmus; in No. 9, a map of the canal line from Lake Nicaragua to the Pacific Ocean, and in No. 10, a general profile of the line arranged in sections.

The total length of the route, from ocean to ocean, is 170 miles, divided as follows:

Canal in excavation, east side	16 miles.	
Canal in excavation, west side	11¾ "	
Six locks	¾ "	
Total canal in excavation		28 miles.
Basin of Deseado	4¼ miles.	
Basin of San Francisco	11¾ "	
Basin of Tola	5½ "	
Total navigation in basin		21 "
Free navigation in river San Juan	64¼ miles.	
Free navigation in Lake Nicaragua	56½ "	
Total free navigation		121 "
Total length from ocean to ocean		170 miles.

The dimensions of the canal-prism are as follows: Width at bottom in ordinary depths, 120 ft.; width at water surface in ordinary soils, 180 ft.; depth, 30 ft. In hard rock the prism has a width of only 80 ft. at bottom, and sides battered about 1 to 20.

There are six locks, three each side, which overcome an elevation on the eastern side of 106 ft., and on the western side of 110 ft., this difference being, as already stated, due to using the natural rise of the San Juan River for 64 miles, at ¾ in. to the mile.

The dimensions of the locks are: Length between mitre-sills, 650 ft.; width (increased from 70 ft. in 1889, and will possibly be increased to 85 ft.), 80 ft.

As to Water Supply, the following is taken from Mr. Menocal's Report, made in 1885, to the Secretary of the Navy:

"Lake Nicaragua has a surface area of 2,600 square miles, and a supplying water-shed of 8,000 square miles. The San Juan River shows a minimum flow of 11,390 cub. ft. per second (984,096,000 cub. ft. daily).

"The estimated water required for one lockage on both sides is 4,046,249 cub. ft.; and estimating 32 double lockages daily, will give 129,479,986 cub. ft. required; leaving an excess, of the lake supply alone, even in the dryest seasons, of 870,520,000 cub. ft.

"To this must also be added the flow of the several tributaries of the San Juan, between the lake and the dam, and also of the San Francisco and its tributaries, which will more than compensate for leakage and evaporation. The latter, however, need not be provided for, it being well known that in these latitudes the condensation during the night fully compensates for the evaporation during the day."

An *Estimate of the Cost* of the canal was made by Mr. Menocal, in 1885, after the present actual location of the line had been determined upon—using the prices for labor, etc., that had been used in computing the cost of the canal as located in 1872–73—finding as follows:

Cost as computed on location of 1885	$39,040,134
Add 25 per cent. for contingencies	9,760,033
Making a total of	$48,800,167
Estimated cost as located in 1873, and under same scale of prices	65,722,147
Reduction of cost, due to new location	$16,921,980

With regard to the prices of labor, etc., used, Mr. Menocal says:

"That the prices to be adopted in estimating the cost of the canal, should be greater than would be required for similar work located in an improved section of this (United States) country, is an admitted fact. A large percentage of this excess will be in the cost of transporting laborers and tools and machinery of every description for the prosecution of the work."

It had also become apparent that the dimensions of the canal, as proposed by Commander Lull's survey in 1873, were not sufficiently large to accommodate the increasing size of vessels; and therefore after the re-location of the line in 1885, computations were made for a canal of larger size.

Notwithstanding the increased size of the locks and the greater depth, the estimated cost, based upon slightly increased prices, was about the same as that of the longer route recommended by Lull, computed under a smaller scale of prices.

The estimate computed from the survey made by Commander Lull, in 1873, amounted to $65,000,000.

The estimated cost of the canal, as now under construction, has not been made public; the Company seem perfectly willing to submit the amounts of excavation, etc., shown to be necessary, but do not care to commit themselves, as yet, to any assertion as to its probable cost.

In addition to the estimate made in 1885, by Mr. Menocal, the Engineer-in-chief of this Company, a second estimate, made after later and elaborate surveys, did not come seriously far from the first.

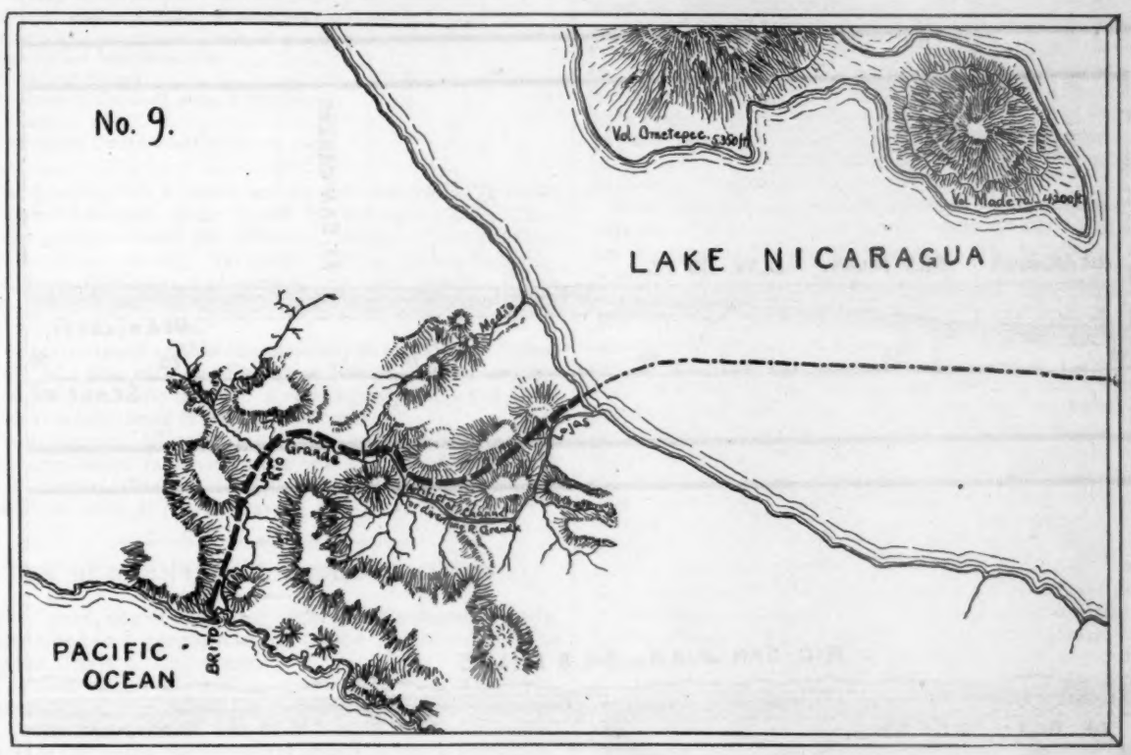
A third estimate was made in the spring of 1889, by a board of five eminent American engineers, none of whom had any connection with the Nicaragua Canal Company.

The report of this board, who made their estimates after some months' work, has not yet been given to the public by the Canal Company, but one can readily believe, from the fact that work is being rapidly pushed in the construction of the canal, that although it may differ somewhat from the first figures, it yet estimates a cost which will permit the remuneration of the Company.

	Per Cubic Yard.
Earth excavation	$ 0.40
Dredging	0.20
Rock excavation above water	1.50
Rock excavation under water	5.00
Stone pitching (rock furnished)	2.00
Concrete	6.00
Concrete foundation of dams	9.00
Concrete abutments	8.00
Narrow gauge railroad (per mile)	16,000.00
Grubbing and clearing (per acre)	100.00

One can, from these figures, form some idea of its cost. It is safe to assume that the *estimated* cost will not exceed $65,000,000, which has been twice announced as the *probable* cost of this canal.

Where it has been impossible to ascertain by borings the character of the strata to be removed, it has been the rule to allow for excavation of rock; hence, all subsequent information obtained will tend to reduce rather than increase the estimated cost.



XXVII.—CONSTRUCTION.

The construction of this canal was begun about June 5, 1889, but not until about the middle of October last did actual removal of earth commence.

With regard to the necessary work to be done, the following figures show the amounts of the larger items:

	Cubic Yards.
Excavation of earth below water	23,489,478
Excavation of earth above water	16,440,368
Excavation of rock above water	15,008,347
Excavation of rock under water	575,445
Improvement of harbors (dredging)	14,714,358
Total excavation	70,227,996
Rock fills, for dams and breakwaters	4,845,787
Earth fills, borrowed, or from cuts	5 085,171
Concrete	518,675
Stone pitching	94,813

The scale of prices used in 1885 by Mr. Menocal, was as mentioned below. He states that he has seen no reason to increase them:

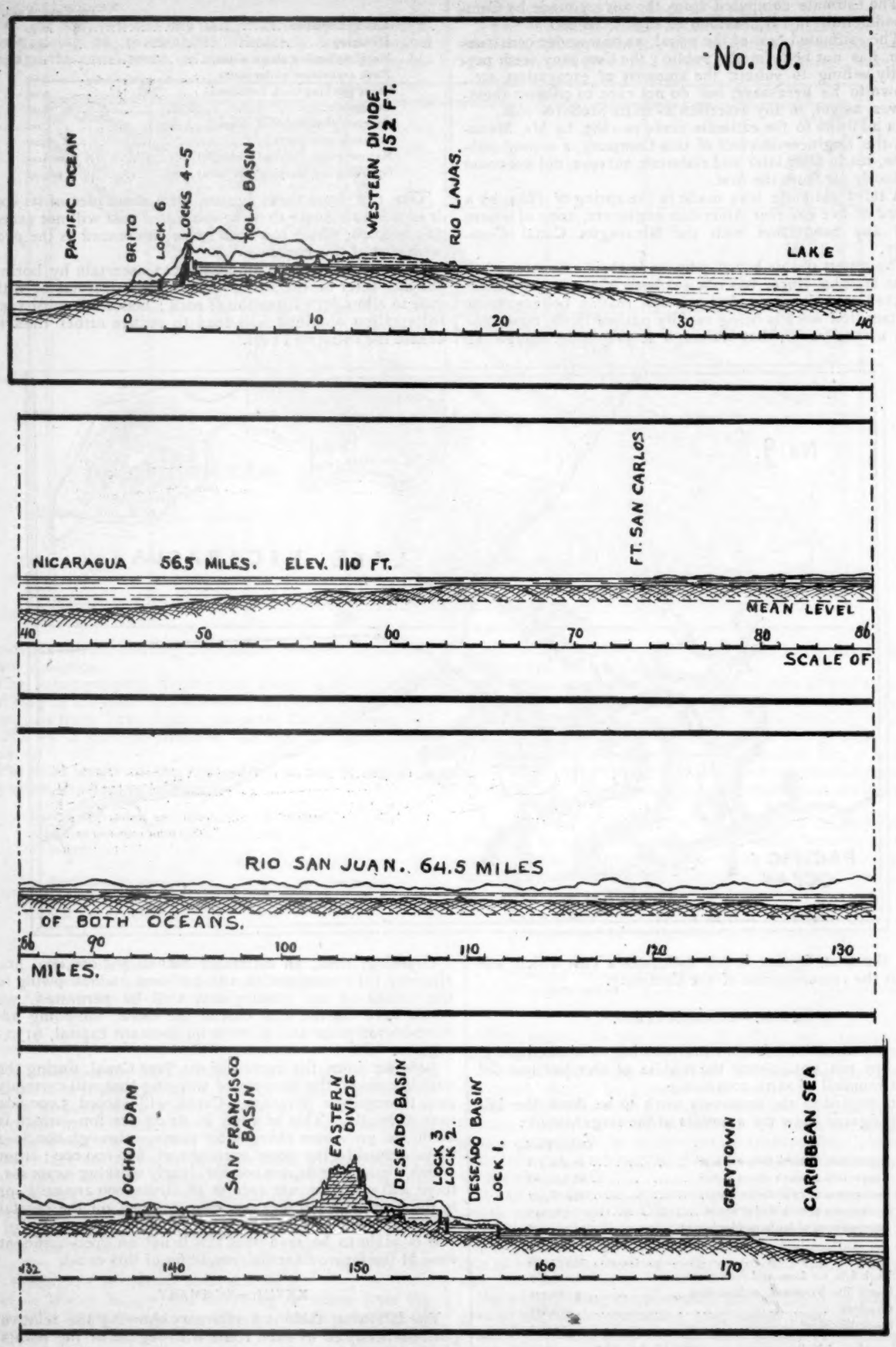
Granting, then, an estimated cost of $65,000,000, and allowing for contingencies 100 per cent., which owing to the nature of the country may well be permitted, we would have, for the total cost of the canal, including administration plant and interest on dormant capital, $130,000,000.

Judging from the record of the Suez Canal, during the past few years, the amount of shipping that will certainly pass through the Nicaragua Canal, will exceed 5,000,000 tons annually. This at a toll of $2 00 per ton—which is about the price now charged for passage through the Suez Canal—would give gross earnings of $10,000,000; from which, deducting $1,000,000 for yearly working expenses, there will remain a net receipt of $9 000,000 annually, or in the neighborhood of 7 per cent. interest on the capital invested.

It is plain to be seen that this is not an over-confident view of the future financial condition of this canal.

XXVIII.—SUMMARY.

The following table is a summary showing the relative position occupied by each route with regard to the points of advantage chosen for comparison. It is considered that the points here expressed are arranged in the order of their importance:



PROFILE OF NICARAGUA CANAL.

Points of Advantage.	Nicaragua.	Panama.	Napipi.
1. Excessive rainfall	1	2	2
2. Necessity of tunnel	1	1	3
3. Water supply	1	2	2
4. Elevation to overcome by locks	1	2	3
5. Rivers to control	2	3	1
6. Healthfulness	1	3	2
7. Length of actual canal line	1	3	2
8. Probabilities of gales along the canal line	2	2	1
9. Character of soil to be excavated	1	3	1
10. Calms of Panama Bay	1	2	2
11. Cost of maintenance	1	2	2
12. Cost of construction, as estimated by American engineers	1	3	2
13. Distance from ocean to ocean	2	1	2
14. Facilities for repairs to vessels	1	2	2
15. Present facilities of transit	2	1	3
16. Established communication with the World's commercial centers	2	1	3
17. Labor obtainable in vicinity of canal line	1	1	3
18. Materials for construction obtainable	2	2	1
19. Supplies and food obtainable	1	2	3
20. Fertility of the soil	1	2	1
21. Proximity to the Gulf ports of the United States	1	2	3
22. Value to the United States in time of war	1	2	3

The opening of a canal across the American Isthmus will greatly benefit those States bordering upon the Mississippi, the Ohio and the Missouri rivers. Their produce and manufactures will find ready transportation to Chile, Peru, San Francisco, and even China and Japan. From New Orleans *via* Nicaragua to Callao, for instance, is only about 2,600 miles.

The importance of this channel-way to the United States in case of a war with any European Power, cannot be overestimated; and should such a contingency arise our Government would have to assume its control.

From present indications the Nicaraguan Canal will be an accomplished fact within the next decade, and we cannot, therefore, afford to delay the launching of a thoroughly efficient force of Naval vessels.

THE BURGENSTOCK CABLE RAILROAD.

This road, one of the latest of the Swiss mountain roads, is described in a recent number of the *Zeitschrift* of the German Union of Engineers.

The line, which was built to give access from the steamboat station Kehrsiten, on the Lake of Lucerne, to the summit of the Bürgenstock, has been opened after long difficulties in obtaining the necessary authority for construction, which was granted only after the favorable report of an international commission, and then only on condition that the carriages should work only from each end to the halfway passing-place and back. This restriction has since been waived, so that the carriages can run right through. It was originally intended to work the descending carriage by water-weight, but owing partly to the expense of getting the necessary quantity of water to the summit, and partly to the extra load, and therefore wear and tear of the ropes, this was abandoned; and the line is actually worked by electricity, the dynamos being set in motion by turbines on a stream about 2½ miles distant.

For the first length of 1,312 ft. from the steamboat pier the incline is 32 per cent.; for the rest of the distance the grade is 57.7 per cent. The horizontal length of the line is 2,713 ft., and the equivalent incline length 3,071 ft., the rise in this length being 1,444 ft. With the exception of a passing-place 394 ft. in length, located on a curve of 558 ft. radius, and at the change of grade, the line is single throughout, and of the meter gauge (39.37 in.). The rails are laid with lead-plate bed on angle-bar sleepers 4 in. × 3⅛ in. in size, firmly secured in cement masonry. The cable is of steel wire, and is 1.18 in. in diameter, composed of 114 wires, and weighing 2.14 lbs. per linear foot. The steel is tested to a load of 89 tons per square inch.

The road is laid with a double plate rack-rail of the Abt pattern, for gearing on the safety brake, by which the speed can be regulated, or the car stopped if necessary. The rack-rail is fixed to the sleepers by stout angle-bars, with a clear intermediate space of 1.1 in. The T-shaped space left is utilized for a device adopted for holding the car to the rails. This consists of a rod fastened to the car frame and having a T-shaped head running in the groove, so that the car cannot be lifted off the rails. The outside wheels are grooved or double-flanged, and the inside wheels (those requiring to pass over the fixed points at the passing-place) are of plain cylindrical form, so that, the outside wheel being guided by the continuous rail, the inner wheel has no difficulty in passing over the rack and the rope grooves at the points.

The car consists of four compartments on an iron frame, the outside dimensions being 19 ft. 8 in. by 5 ft. 3 in. There are two axles 9 ft. 10 in. apart. The general brake arrangements resemble those on the Pilatus Railroad. The car weighs 8,800 lbs., and accommodates 30 persons, the total load being therefore about 13,200 lbs., and the maximum tangential force 6,600 lbs. Adding the weight of the rope and the friction in hauling and winding, the total strain is equal to 13.46 tons, which gives nearly seven as the factor of safety. The vertical cast-iron grooved rollers for the rope are 6¼ in. in diameter, spaced at intervals of 49 ft.; the diameter on curves, where the rollers are set in angular bearings, being 24 in. The average speed is 197 ft. per minute, or 2.236 miles per hour, giving therefore a little over 15 minutes for the entire journey.

The water-power is derived from the Aa, between the villages of Stanz and Buochs, at a point about 1,400 ft. below the level of the summit station. The volume of water is nearly 40,000 gallons per minute, with a fall of 16 ft. 6 in.; and taking the effective work at 75 per cent., the power developed is equivalent to 150 H.P. The turbines make on an average 49.5 revolutions per minute, the vertical shafts being geared by bevel wheels on to a horizontal shaft, making 145 revolutions and working two Thury dynamos at 800 revolutions. The effective power developed is 88.8 per cent., and the current is transmitted by the triplex system to the summit station on the Bürgenstock, where the electrical energy is reconverted into mechanical work. The total weight of copper wire is 3,750 lbs., whereas the weight required for duplex transmission would have been about 10,000 lbs. The electro-motors at the Bürgenstock station make 700 revolutions a minute, giving 170 revolutions to the main driving-shaft and 5 revolutions to the 13-ft. diameter winding rollers. The dynamos are also used for the electric light installation, which comprises 225 glow-lights and one 2,000-candle arc-light. The stations and the turbine-house are also connected by telephone, and the cars in approaching each end of the line cause a bell to sound in the engine-room, while the exact position of each car is reproduced diagramatically in the engine-room by indicators moving in the proportion of 1 to 1,000 of the travel of the rope. When not employed for working the line or the light installation, the electro-motors are used for pumping water to the summit, from a point 1,300 ft. below. The water is raised 6 ft. 6 in. by suction, and then forced through a 2-in. pipe to the summit level, at the rate of about 31 gallons per minute.

FOREST CULTURE IN HANOVER.

(Report by Consular Agent Simon to State Department.)

In various parts of the United States the question has been raised, by what measures the preservation of forests and the plantation and culture of trees might be most effectually promoted in parts void of timber. In connection with this it might be desirable to learn something about the state of forest management in the province of Hanover. This province, the former Kingdom of Hanover, had rich tracts of forests in former centuries, which, in consequence of civil and other wars at various times, were reduced to desolate wastes and remained so until the first decades of the present century, particularly those ex-

tents between Hamburg and Hanover, which are known by the name of Luneburger Haide (Lunenburg Heath).

Besides those wars, another reason for such devastation is to be attributed to uncongenial management, such as division of common forests, by which they were dispersed and fell into the hands of people with small means, and thus were doomed to neglect and destruction. Those singly situated wooded tracts, for want of screenings, have greatly suffered by the detrimental, inclement winds, which is easily understood, since large forests will defy the violence of storms better than small woods.

Great credit for having made up for past neglect and faults is due to the celebrated Burkhardt, who, being a great authority in this matter, was appointed Director of the forest department in 1850. Part of the Luneburger Haide, as well as other tracts growing more and more desert by the encroachments of sand, have been wooded with great pains and trouble at his instigation. To prevent the increase of sandy deserts those tracts were at first planted with fir-trees. These could, in some parts, after a number of years, be cleared and substituted by beach and other trees. How much the forests have been enlarged in this manner will appear by the following statement: The wooded surface amounted in the year 1850 to 1,217,625 acres; 1885, to 1,551,900 acres. By such plantation of trees river-bank and sea-shore tracts have been solidified. In consequence of the notorious fact that forests have a great influence on the climate and the attraction of moisture, meteorological stations have been established. Forests serve, moreover, as bulwarks against violent winds, and equalize to some extent the extreme differences of temperature. The absorption of water by trees and undergrowth after heavy rains or melting of snow is very considerable, particularly in such tracts where the forest soil predominates; so that well-wooded hills and mountains are the best protection against destructive inundations. In order to promote the establishment of forests in every respect, the Government has granted large sums for the purchase of landed property unfit for cultivation to be turned into forest tracts. The Government is now keenly intent to unite again those formerly scattered wooded parts into one single tract. In the same way the Provincial Government and Klosterkammer (Administration of cloister funds) proceed by purchasing extensive stretches of soil. The Klosterkammer administers the large funds of the secularized cloisters of the former Kingdom of Hanover, now used for the support of universities, schools, and churches in this province.

Municipalities, communities, and even private individuals who are inclined to establish forest grounds and manage them rationally will receive loans at 2 per cent. and even cheaper from the Provincial Government, to be reimbursed yearly by small installments. Also, single subsidies are granted for once for the turning of large wastes into forest grounds. For the latter purpose the provincial government resorted to a new and original method, by using vagabonds, tramps and prisoners not of a dangerous character for forest culture, and, indeed, according to experience, with great advantage both with regard to the workers and forest culture. In this manner about 9,000 acres were planted with trees by those troublesome classes within the years 1876 to 1888. Moreover, communities as well as private individuals have turned about 14,000 acres into forest grounds within the same period by means of subsidies afforded by the Provincial Government. Besides, the matter of forest culture is encouraged and promoted on the part of the Government, as well as the provincial authorities, by the establishment of nurseries, where plants and young trees are to be had at very moderate prices.

By a legal preservation of forests in the vicinities of towns pleasant walks are created for the pleasure and health of the inhabitants, without regard to the material profit of those places. At a short distance from the old city of Hanover, for instance, was the so-called Eilenreide, a forest of about 1,500 acres, which the city now partly encircles. This forest has essentially contributed to the reputation of Hanover, with regard to sanitary condition, to the extent of its being now, according to statistics, one of the healthiest cities in Germany. Several smaller towns which own extensive forest grounds and manage them in a rational way, clear by the net yielding of those woods the whole of their municipal expenses; as, for instance, the town of Munder, situated at the foot of the Deister Mountains. The town of Goslar derives an income of $25,000 to $30,000 from an extent of 7,500 acres of forest grounds. Every traveler on an excursion to Goslar and other parts of the Hartz Mountains will have admired the fine, practical forest roads which facilitate the transport of wood. It has been estimated that, by the higher prices which the town receives at the sale of the wood on account of the easier transport, the capital invested in making these roads and keeping them in good condition yields 20 per cent. yearly.

THE USE OF WOOD IN RAILROAD STRUCTURES.

By Charles Davis Jameson, C.E.

(Copyright, 1889, by M. N. Forney.)

(*Continued from page 257.*)

CHAPTER XXVI.

HOWE TRUSS BRIDGES.

With this chapter is given the design for a Howe truss through bridge of 54 ft. span. In Plate 112 will be found the general elevation and plan, with strain sheet; in Plate

No. 46. Bill of Material for Howe Truss Bridge, 54 Ft. Span. Plates 112, 113, 114 and 115.

Timber.

No. of Pieces.	Description.	Size.	Length.	Material.
2	Top Chord.....	6 in. × 12 in.	15 ft. 6¾ in.	Yellow Pine.
2	" "	6 in. × 12 in.	24 ft. 6¾ in.	" "
1	" "	8 in. × 12 in.	40 ft. 1 in.	" "
2	Bottom Chord.....	6 in. × 14 in.	16 ft. 6 in.	" "
2	" "	6 in. × 14 in.	43 ft. 6 in.	" "
1	" "	8 in. × 14 in.	25 ft. 0 in.	" "
1	" "	8 in. × 14 in.	35 ft. 0 in.	" "
8	Braces	12 in. × 9 in.	25 ft. 0 in.	" "
8	"	10 in. × 8 in.	25 ft. 0 in.	" "
8	"	9 in. × 7 in.	25 ft. 0 in.	" "
8	Counters.....	9 in. × 7 in.	25 ft. 0 in.	" "
4	End-post braces....	9 in. × 7 in.	14 ft. 0 in.	" "
6	Top laterals.	8 in. × 8 in.	18 ft. 2⅛ in.	" "
8	Bottom laterals.....	8 in. × 8 in.	17 ft. 10 in.	" "
2	" "	8 in. × 8 in.	16 ft. 4⅛ in.	" "
8	Bolsters.....	6 in. × 10 in.	9 ft. 0 in.	" "
4	"	8 in. × 10 in.	9 ft. 0 in.	" "
8	Bridge-seats.....	6 in. × 10 in.	4 ft. 6 in.	" "
4	" "	8 in. × 10 in.	4 ft. 6 in.	" "
4	Sills.....	12 in. × 12 in.	18 ft. 0 in.	Spruce or Pine.
22	Floor-beams	9 in. × 16 in.	17 ft. 10 in.	" " "
6	Stringers	6 in. × 12 in.	60 ft. 0 in.	" " "
52	Ties.....	8 in. × 8 in.	12 ft. 0 in.	Oak.
2	Guard-rails.....	6 in. × 6 in.	60 ft. 0 in.	Spruce or Pine.
4	Foot-planks	2 in. × 6 in.	60 ft. 0 in.	" " "
8	Keying blocks.....	2 in. × 8 in.	2 ft. 0 in.	Oak.

Wrought-Iron—Rods and Bolts.

No.	Description.	Diameter.	Length.	No.	Description.	Diameter.	Length.
8	Rods.	2¾ in.	26 ft. 10 in.	12	Brace-bolts.	⅞ in.	2 ft. 0½ in.
8	"	2 in.	26 ft. 10 in.	12	Bolster-b'lts	1¼ in.	2 ft. 2 in.
4	"	1⅝ in.	26 ft. 10 in.	12	" "	1¼ in.	3 ft. 0 in.
2	Top laterals	1½ in.	18 ft. 6 in.	44	Fl.beam b'ts	1¼ in.	3 ft. 6 in.
2	" "	1⅜ in.	18 ft. 6 in.	44	String'rb'lts	¾ in.	2 ft. 6 in.
4	Bottom lat.	1¾ in.	18 ft. 6 in.	104	Tie-bolts.	¾ in.	1 ft. 10 in.
2	" "	1⅜ in.	18 ft. 6 in.	34	Guard-bolts.	¾ in.	1 ft. 4 in.
124	Chord-bolts.	¾ in.	2 ft. 0½ in.	40	Spikes.	½ in.	.....

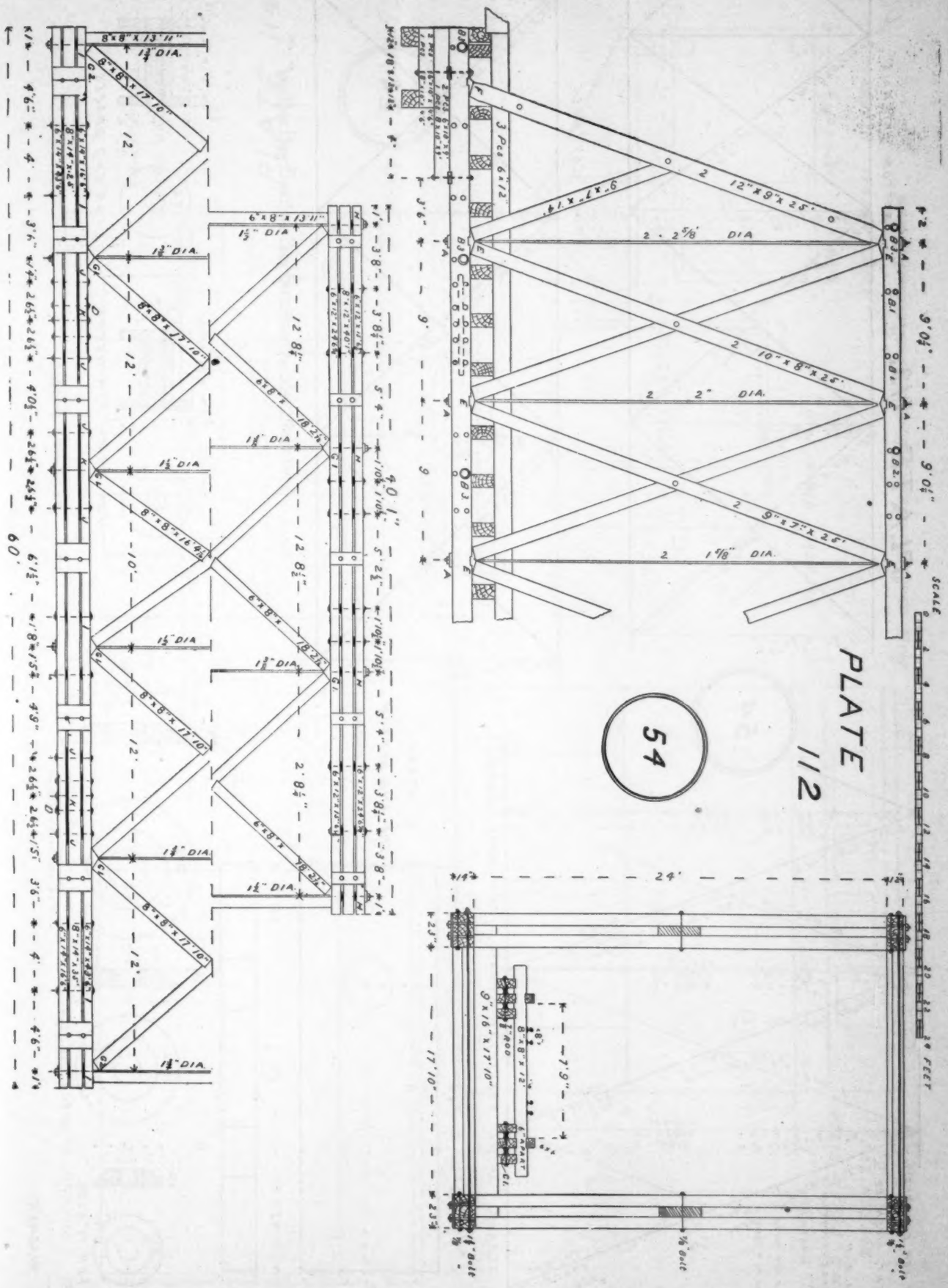


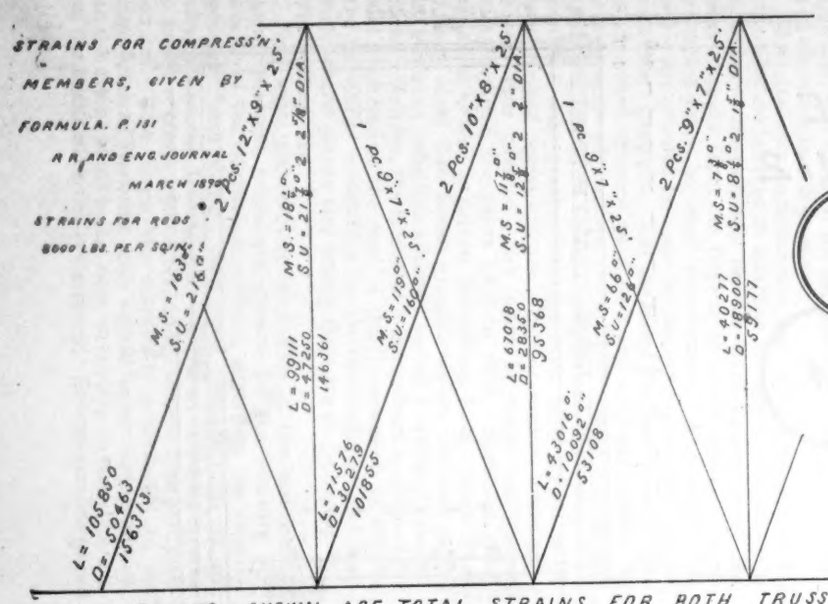
PLATE 112
54
SCALE
FEET
60'
24'
12'
10'
2 12"x9"x25"
2 10"x8"x25"
2 9"x7"x25"
2 2 5/8" DIA
2 2" DIA
2 1 5/8" DIA
3 Pcs 6"x12"
9"x7"x1/4"
8"x8"x13'11"
8"x8"x17'10"
8"x8"x16'4½"
6"x8"x18'2½"
6"x8"x18'2½"
6"x8"x13'11"
1¼" DIA
1½" DIA
1⅝" DIA
1¾" DIA
1⅞" DIA
2" DIA
9"x16"x17'10"
8"x8"x12'
1" Rod
⅛" Bolt
1¼" Bolt

PLATE 113.

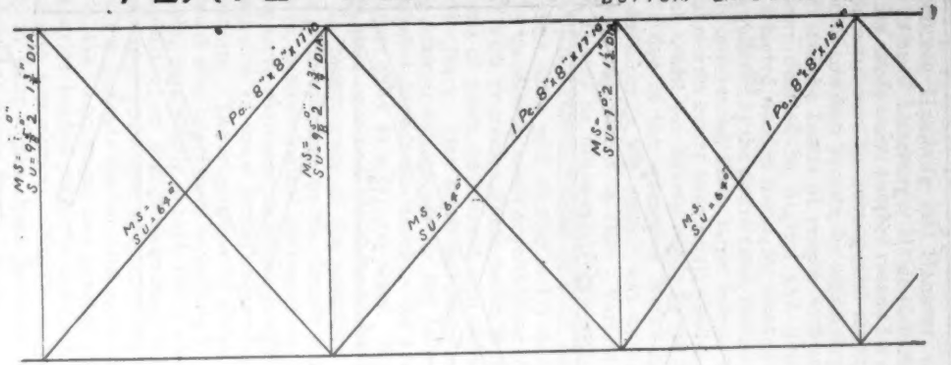
54

STRAINS FOR COMPRESS'N MEMBERS, GIVEN BY FORMULA. P. 131 R.R. AND ENG. JOURNAL MARCH 1890.

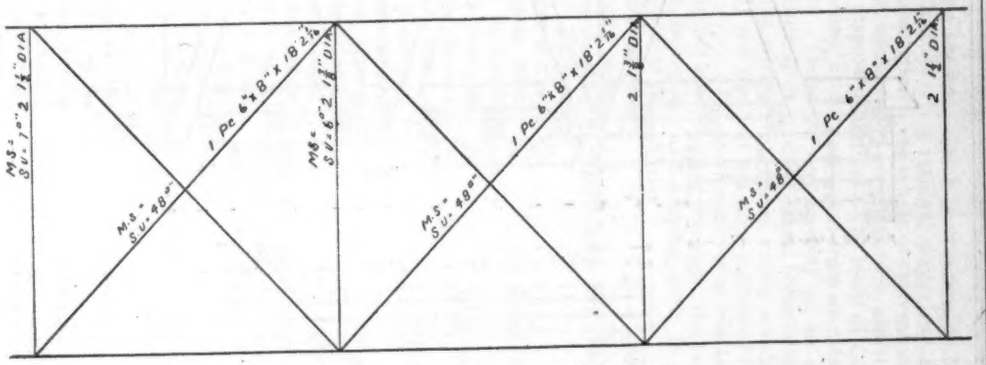
STRAINS FOR RODS 8000 LBS. PER SQ. IN.



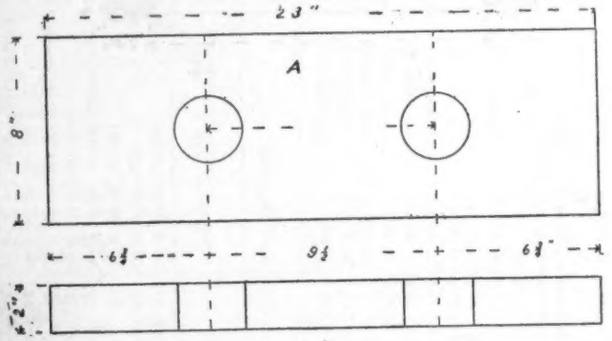
BOTTOM LATERALS



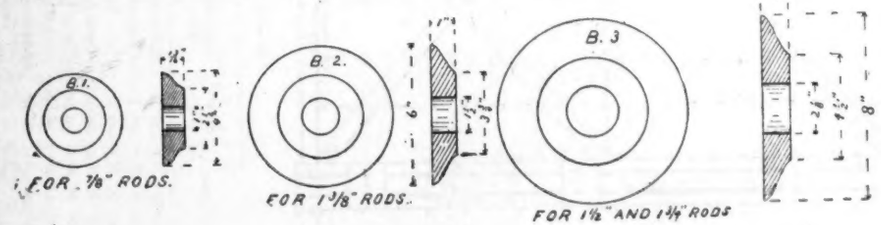
TOP LATERALS.



SCALE. 0 2 4 6 8 10 12 14 16 18 20 22 24 IN.

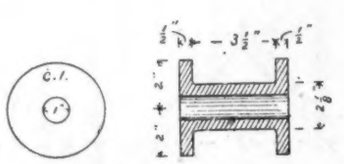


A STRAP TOP AND BOTTOM CHORD

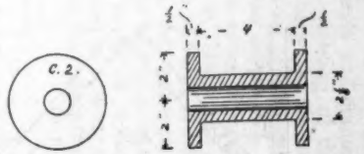


FOR ⅞" RODS. FOR 1⅛" RODS. FOR 1½" AND 1¼" RODS

WASHERS.



FOR TRACK STRINGERS



FOR END BRACES

PACKING SPOOLS

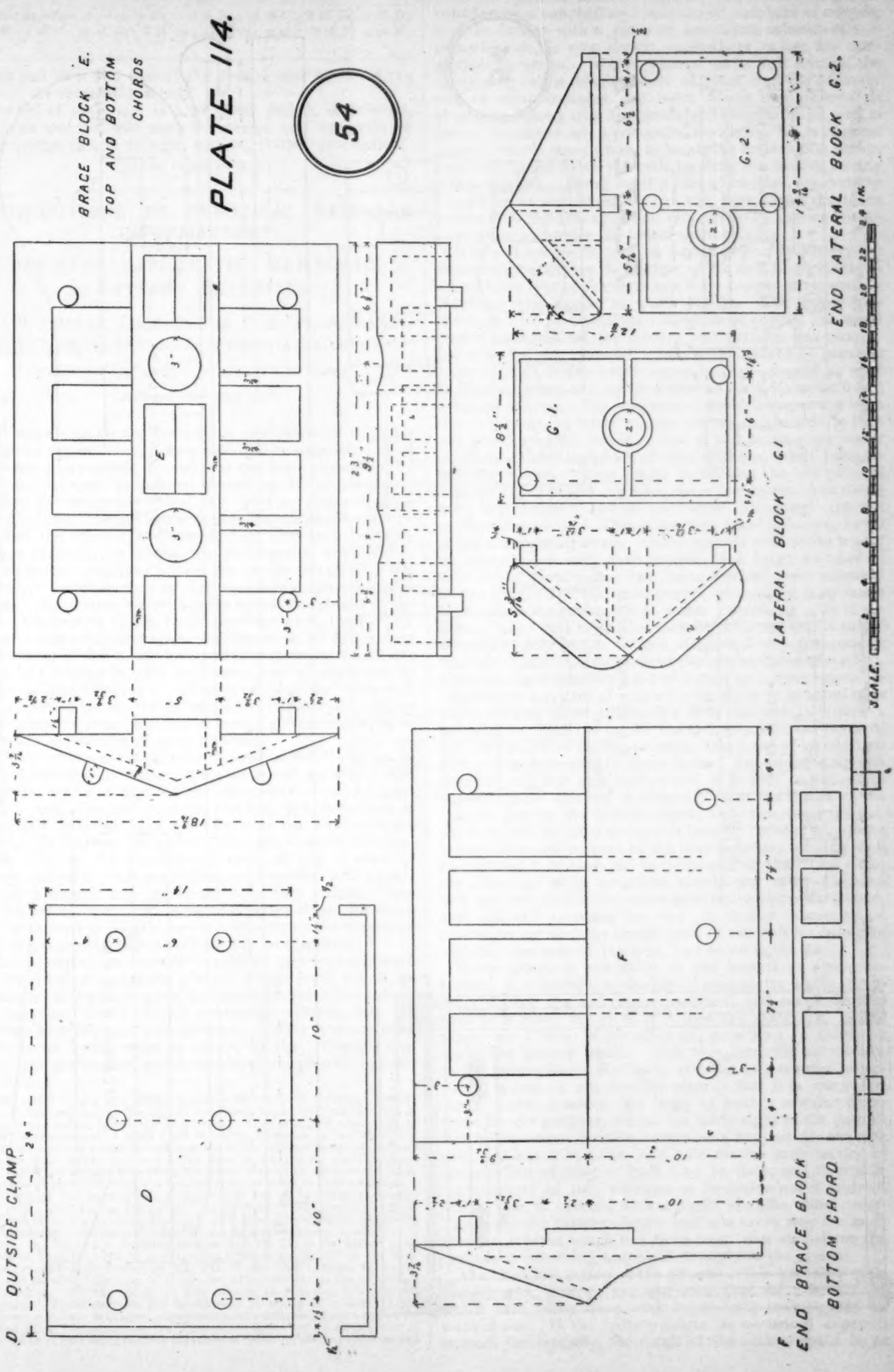
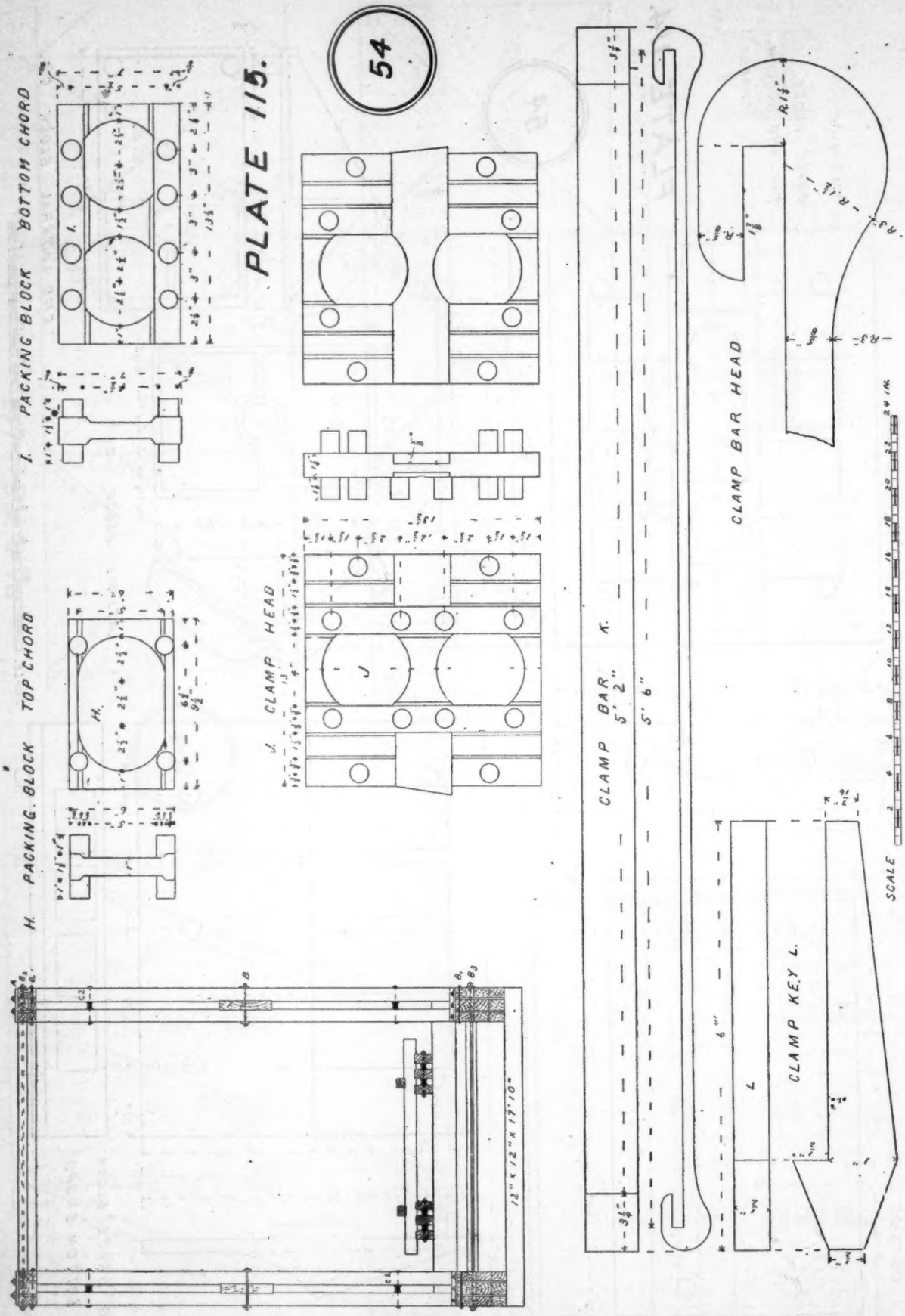


PLATE 114.
54
BRACE BLOCK E.
TOP AND BOTTOM CHORDS
E
G.2.
END LATERAL BLOCK G.2.
G.1.
LATERAL BLOCK G.1
SCALE.
D OUTSIDE CLAMP
F
END BRACE BLOCK
BOTTOM CHORD


54
PLATE 115.
I. PACKING BLOCK BOTTOM CHORD
H. PACKING BLOCK TOP CHORD
J. CLAMP HEAD
CLAMP BAR K.
5' 2"
5' 6"
CLAMP BAR HEAD
CLAMP KEY L.
SCALE
12" x 12" x 17'10"

Castings.

Pieces: 24 straps *A*; 636 of *B*1; 136 of *B*2; 36 of *C*1; 8 of *C*2; 2 of *D*; 24 of *E*; 4 of *F*; 12 of *G*1; 8 of *G*2; 48 of *H*; 72 of *I*; 8 of *J*; 4 of *K*; 8 of *L*.

113 an end view and part of the details, and in Plates 114 and 115 the remaining details.

The bill of materials is also given, and, it is believed, the plates and bill will show the design and construction of the bridge clearly enough, without further description.

(TO BE CONTINUED.)

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.*

CHEMISTRY APPLIED TO RAILROADS.

X. BATTERY MATERIALS.

By C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad.

(Copyright, 1889, by C. B. Dudley and F. N. Pease.)

(*Continued from page* 313.)

To those who do not understand the details of railroading at the present day, it may perhaps be somewhat of an astonishing statement to say that the train movement on any busy railroad at present would be an impossibility without the telegraph; and this does not mean that the operation of a railroad requires that the telegraph shall be used for the officers to communicate with each other on matters of policy, or about the purchase of supplies, or other general questions which are constantly coming up, important as these may be for the general operation of a railroad, but it does mean that the actual movement of the trains, the getting of the traffic over the road, the prevention of delays, collisions, and accidents of all kinds, and the meeting of the dozen and one emergencies, which are constantly arising in train movement, are all regulated by means of the telegraph, and that without the telegraph complicated train movement would be impossible, at least without such a multiplication of tracks as would double or treble the investment of most railroads.

In view of the great reliance placed on the telegraph in modern railroad operation, the question of materials used in the battery to furnish the electricity with which to operate the lines assumes new importance, and the object of this article is to give the experience of the Pennsylvania Railroad in *Battery Material*. The questions of the telegraph lines, of the construction used, of size of wire, of distance of poles from each other, of overhead and underground lines will not be discussed in this article. Possibly in some future article of this series these questions may be treated at length, but at present only the materials used in generating the electricity will be discussed.

The history of the battery as applied to telegraph work and the development of the present simple form, which, so far as our knowledge goes, is almost universally used for this purpose, would be very interesting reading, but this likewise is foreign to our purpose. Suffice it to say that, so far as we know, what is known as the "Gravity Battery," the elements of which consist of one pole of metallic zinc, one pole of metallic copper, the latter being surrounded by a concentrated solution of sulphate of copper, and the former with a more or less dilute solution of sulphate of zinc, is now almost everywhere in use for telegraphic purposes. In this battery, as is well known, the containing cell is usually made of glass, and the ordinary size in most common use holds about one gallon. It should be placed in a dry, moderately warm room, and is best if insulated on a porcelain insulator. It is a great mistake, made many times, to locate the battery in a damp, cold cellar, and to set the cells forming the battery on any damp support. Being itself a part of the line, the battery should be as well insulated as the wire, and experience shows that the leakages and difficulties in service disappear more and more the better the insulation.

It is well known that in an ordinary gravity battery the copper pole occupies the bottom of the cell, being connected with the zinc of the next cell by a copper wire, usually insulated with rubber or gutta percha. The copper pole is surrounded by crystallized sulphate of copper, the usual custom being to fill the battery cell perhaps one-quarter full with the dry material. Soft water as free as possible from mineral matter—rain water is best—should be used to fill the battery cell up to within an inch or an inch and a half of the top. The zinc pole of the cell suspended from the cover, or by a bar across the top of the cell, is then put into the water, and it is best to add to the clear water solution a little sulphate of zinc solution, taken from an old battery cell. Many prefer to connect the two poles of a newly charged cell together for a few hours, thus doing what is technically known as "short circuiting" the cell to start the action. This is not very good practice, but it is quite frequently done. Quite serious difficulties would be experienced with this method, if a large number of cells in any battery that was being worked were renewed at one time, since the resistance of pure water is so much higher than the resistance of water containing salts in solution. The best method of starting a battery cell is to put the copper pole in the bottom of the cell and surround it with the crystallized sulphate of copper, as above described. Then fill about one-third full of water, or a little above the crystallized sulphate of copper, and allow it to stand over night. Then fill in above this blue solution to within 1 in. or 1½ in. from the top of the cell with a liquid made of one part sulphate of zinc solution, taken out of an old battery cell, and two parts clean water. In introducing this solution into the new battery cell, it is best to put a thin board, a little smaller in diameter than the inside of the cell, on top of the blue solution, and then pour the sulphate of zinc solution on to this board. In this way there is very little disturbance of the blue solution, it being well known that it is essential in the action of the battery that the blue and white solutions should not mix. Suspend now the zinc pole in the white solution as above described, and the cell is ready for use. It is not necessary, of course, to say that the copper pole of one cell is connected with the zinc pole of the next, and so on to the end.

In the practical operation of the battery as above described, it is found that the liquid evaporates badly, especially during dry and warm weather, and many devices have been made use of to overcome this difficulty. Some people use a layer of paraffine oil, possibly ¼ in. thick, on top of the battery liquid. This was formerly the custom on the Pennsylvania Railroad, and the only serious objection to it that we are familiar with is that it is somewhat dirty. Later practice has been to have a wooden cover made for the purpose, which fits fairly tight to the battery cell, which cover likewise serves as a support for the zinc pole, and has in it a two-inch hole for the introduction of the sulphate of copper from time to time, and to enable the sulphate of zinc solution to be drawn out if desired, which hole is covered with a small metallic slide cover. This keeps the battery cleaner and is in every way the most efficient scheme which has been tried, and we believe the practice is becoming universal throughout the system.

The chemical action of the gravity cell is probably quite complicated, and we are not sure that all the reactions which take place have ever been fully investigated or worked out. If the battery works as we would expect it to work theoretically, the result of the action would be as

* The above is one of a series of articles by Dr. C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad, who are in charge of the testing laboratory at Altoona. They will give summaries of original researches and of work done in testing materials in the laboratory referred to, and very complete specifications of the different kinds of material which are used on the road and which must be bought by the Company. These specifications have been prepared as the result of careful investigations, and will be given in full, with the reasons which have led to their adoption.

The articles will contain information which cannot be found elsewhere. No. I, in the JOURNAL for December, is on the Work of the Chemist on a Railroad; No. II, in the January number, is on Tallow, describing its impurities and adulterations, and their injurious effects on the machinery to which it is applied; No. III, in the February number, and No. IV, in the March number, are on Lard Oil; No. V, in the April number, and No. VI, in the May number, on Petroleum Products; No. VII, in the June number, on Lubricants and Burning Oils; No. VIII, in the July number, on the method of purchasing oils; No. IX, also in the July number, on Hot Box and Lubricating Greases. These chapters will be followed by others on different kinds of railroad supplies. Managers, superintendents, purchasing agents and others will find these CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION of special value in indicating the true character of the materials they must use and buy.

follows: Metallic copper from the sulphate of copper is deposited on the copper pole in the bottom of the cell. This releases the sulphuric acid with which the copper was combined in the sulphate of copper. This sulphuric acid ultimately combines with the zinc, forming sulphate of zinc, which goes into solution and stays in the top of the cell around the zinc pole. We say theoretically this is the action of the battery, namely, a transfer of sulphuric acid from its combination with copper in sulphate of copper, to the metallic zinc, and forming sulphate of zinc; but in addition to this, there is always a coating of oxide and basic sulphate of zinc formed on the zinc pole. This deposit is usually said to be the result of "local action," but whether this explains the phenomenon or not we are unable to say, and it is hardly essential to our purpose to go into this part of the subject. It will be observed that as the action of the battery continues, there will be an increase in the amount of metallic copper, a diminution in the amount of sulphate of copper, a diminution in the amount of metallic zinc, and an increase in the amount of sulphate of zinc. The care of the battery, therefore, requires the addition of two things, and the removing of two things, namely, sulphate of copper and new zinc must be added, and the metallic copper and the sulphate of zinc must be removed. In practice it is usually customary to add the sulphate of copper from time to time through the hole in the cover, and to draw out the sulphate of zinc, as the solution becomes too concentrated, replacing it with pure water from time to time. Whenever it is necessary to furnish new zinc or to remove the metallic copper, usually the cell is cleaned out entirely and a fresh start made.

It is very easy to see when more sulphate of copper is needed, and it not infrequently happens, if a battery is neglected, that a difficulty arises from the exhaustion of sulphate of copper. The most common difficulty, however, is in allowing the sulphate of zinc to become too concentrated.

When this occurs a thin layer of crystallized sulphate of zinc frequently forms on the inside of the cell at the top of the solution, which layer gradually extends to the top of the cell, and the liquid creeps up between this layer and the glass of the cell, until it runs over the top. This creeping up of the liquid makes very dirty cells and interferes seriously with the insulation, since as soon as the liquid gets to the top it runs down on the outside and interferes with the insulation of the cell. In good battery practice the sulphate of zinc solution should never be allowed to become as concentrated as this. Most of the books of instruction to those having the care of batteries contain directions in regard to allowing the sulphate of zinc solution to become too concentrated, and recommend to employ a hydrometer to take the density of the solution, and never allow it to reach the danger line of concentration.

With good materials and with proper care the gravity cell gives very good results, although its electro-motive force is, as is well known, rather low, and the number of cells required consequently much greater than could be desired. We do not, however, know of anything better at the present time than the ordinary gravity cell, and when, as is the ordinary custom we believe almost everywhere, the lines are worked on closed circuit, the behavior of this cell, if it gets the care it ought to have, is fairly satisfactory.

If the action of the battery was simply confined to that which has been described above, namely, to the deposition of the metallic copper and the formation of sulphate of zinc, it is unquestioned that the purer the sulphate of copper and the purer the metallic zinc, the better the action of the battery would be. We have expressed a doubt as to whether even the normal action of the battery was wholly explained by this simple reaction, and still further expressed a doubt as to whether the impurities which are necessary concomitants of the zinc and sulphate of copper used, or "local action" are complete explanations of all the additional reactions which may take place in the battery. Every effort has been made for a number of years past on the Pennsylvania Railroad to secure the purest possible materials for battery use, but this effort has not succeeded in preventing the deposition of scale on the zinc pole, and, as above described, it is possible that the impurities in the zinc, or "local action" may be the cause of this difficulty, and that no commercial zinc can be obtained which will be free from it, or, in other words, although the purest commercial materials are used, there is still enough impurity left to set up "local action," with the result of forming a scale on the zinc pole, as above described. We are hardly able to set this point at rest. One thing is certain, however, that impurities in the zinc are not desirable, and certain impurities are exceedingly objectionable, as will be described below. In order to reduce the impurities to the least possible amount, zinc for battery use has for some time been bought on the Pennsylvania Railroad, in accordance with the following specifications:

PENNSYLVANIA RAILROAD COMPANY.

Motive Power Department.

Specifications for Zinc.

Ordinary Slab Zinc or Spelter, and Rolled or Cast Rod Zinc used for battery purposes, will be bought under this specification. It does not apply to Sheet Zinc nor to Galvanized Iron.

The material desired is Metallic Zinc, as free as possible from every other substance.

Shipments will not be accepted which show on analysis in addition to the Zinc more than one-fourth of 1 per cent. of Lead, or more than one-tenth of 1 per cent. of any other substance.

THEODORE N. ELY,
General Superintendent Motive Power.

Office of the General Superintendent Motive Power, Altoona, Pa., April 2, 1887.

When a shipment of zinc is received, it usually comes in the form of slabs about an inch thick, 7 or 8 in. wide, and 2 ft. long. These slabs are known in the market as spelter.

A sample from the shipment is sent to the Laboratory and examined. It will be observed that more than 0.25 per cent. of lead is excluded, and more than 0.10 per cent. of any other substance. The ordinary impurities in zinc that we search for are lead and iron, these being the most common ones. The zinc may likewise contain small amounts of arsenic, tin, cadmium and copper. We have also always suspected the presence of carbon, but have never positively demonstrated whether it was there or not. American zincs have very small amounts of arsenic; most of the foreign zincs have very perceptible amounts of it. We have never had any very serious difficulties due to any impurities except iron and lead, and so far as our examinations have gone, the tin, cadmium and copper are very small in amount. The worst impurity is lead, and it is very evident why this should be so. As has already been described, the action of the battery consists in the transfer of the sulphuric acid combined with the sulphate of copper to the zinc. If now the zinc pole contains 1 or 2 per cent. of lead, the sulphuric acid forms with this lead sulphate of lead, which being insoluble in the solution, remains on the zinc pole, and sooner or later the zinc pole becomes so coated with a compact, dense layer of sulphate of lead, that the action of the battery almost entirely ceases. We have examined a number of times zincs which have been complained of where this was entirely the explanation of the difficulty. The zinc was not half worn out, simply because the sulphate of lead formed prevented further action, and, of course, without action no electricity results. We would be glad if we could get zinc entirely free from lead, and at one time succeeded pretty well on this point; but zinc free from lead is so much more expensive than that containing such amounts as our specifications allow, that we deemed it not advisable to buy the more expensive material. We have very little if any difficulty arising from this cause if the zinc fills the requirements of our specifications.

The iron is limited, as is seen, to 0.10 per cent. Unquestionably the iron is the most fertile cause of so-called "local action"—that is to say, the iron and the zinc in contiguous parts form a battery by themselves, resulting in the decomposition of the metal, but affording no useful current, and it is possible, as above stated, that the scale which forms on the zinc pole may be fully accounted for by the local action due to the impurity. That the iron has an important influence in this matter is clear, we think, from this fact. The more iron there is present in the zinc, the more scale there is formed on the zinc pole, and likewise the more this scale breaks up and falls off from the zinc. Indeed, one of the objections made to our specifications, is that they give a zinc which is too pure, and

that the scale on the zinc pole does not disintegrate and break up owing to the lack of impurity. Many practical battery men believe that the white scale which forms on the zinc pole should be detached from time to time, or else the battery will cease to act. Our experience has not indicated this to be true, unless this white scale on the zinc pole is largely sulphate of lead, in which case it is true. We prefer to meet the difficulty of the scale adhering to the zinc pole by the addition of a few drops of sulphuric acid to the cell from time to time, or perhaps better still by a modification of the zinc. We are making experiments upon this point at present, which experiments are hardly sufficiently advanced to warrant publication. So far as our experience goes, however, very little difficulty will be experienced by the white scale on the zinc pole, provided the scale is not due to lead, and at present the best remedy is to add a few drops of oil of vitriol to the battery cell from time to time.

In casting battery zincs out of the slab spelter the metal should never be melted in an iron vessel, since it is well known that the zinc alloys with iron rapidly. In our experience we have found the amount of iron doubled in the finished zinc from what it was in the zinc with which we started, when we melted in an iron vessel. At present the melting is done in a large flat graphite crucible, made for the purpose.

We determine the amount of iron present in the zinc by dissolving the zinc in dilute sulphuric acid in a flask, using a rubber tube valve, to prevent the air getting at the liquid, and then titrate direct with permanganate of potash in the ordinary way. For the lead the metal is dissolved in nitric acid, and the lead precipitated in ammoniacal solution with phosphate of soda, according to Abel and Field's method, the lead being subsequently weighed as sulphate.

The sulphate of copper used in the batteries is purchased on the following specifications :

PENNSYLVANIA RAILROAD COMPANY.

Motive Power Department.

Specifications for Sulphate of Copper or Blue Vitriol.

The material desired under this specification is the Normal Crystallized Sulphate of Copper, as free as possible from all other substances. From this date this material for the use of the Pennsylvania Railroad Company must meet the following requirements :

I. It must not contain more than $\frac{1}{4}$ of 1 per cent. of Crystallized Sulphate of Iron.

II. It must not contain more than $\frac{1}{4}$ of 1 per cent. of other impurities.

III. Each shipment must be crushed so as to go through a sieve $1\frac{1}{4}$ in. mesh, and must contain nothing that will go through a sieve of $\frac{3}{16}$ in. mesh.

Shipments which fail to meet above requirements will be rejected.

THEODORE N. ELY,
General Superintendent Motive Power.

Office of the General Superintendent Motive Power, Altoona, Pa., January 25, 1887.

It is well known by those who are well informed on the subject that the ordinary impurity of the sulphate of copper is almost entirely sulphate of iron, and sand or dirt. There may likewise be other substances present, especially other soluble sulphates, which crystallize along with the sulphate of copper. Since these other substances, to quite an extent, at least, would be direct falsifications, and are so easily detected, we think there is very little attempt among the manufacturers to give a material that is not what it should be. At least, so far as our experience goes, we have found very little to contend against in this material except the sulphate of iron. This at times might become quite a serious source of difficulty, and accordingly every shipment is examined for this impurity, the search for other impurities being confined to occasional more thorough analyses. With proper care on the part of the manufacturers, the specifications in regard to sulphate of copper are not difficult to fill. Much of the blue vitriol in the market runs as high as 0.75 to 1.00 per cent., and indeed we have seen it as high as 1.50 per cent. sulphate of iron. The object of excluding this material is to render the action of the battery as simple as possible, as well as to prevent the purchase of sulphate of iron, which is an exceedingly cheap substance, at the price of sulphate of copper. The crushing of the crystals is to facilitate the introduction of the material in through the hole in the cover of the battery cell, as above described. The specifications for blue vitriol have worked with very little difficulty for a number of years, and it has been a long time since we were compelled to reject material on these specifications. We determine the sulphate of iron by dissolving a weighed amount of blue vitriol as we receive it in water, heating nearly to boiling, and adding a few drops of nitric acid to be sure that the iron is oxidized to the form of the sesqui salt. We then precipitate hot with ammonia, filter and treat the oxide of iron obtained on the filter with dilute sulphuric acid, and then reduce this with zinc and titrate with permanganate of potash. The figure obtained, representing the iron, is then calculated to the crystallized sulphate.

The gravity cell as above described is growing in use continually, but a small number of Leclanche cells are used, especially on call and signal bells, and where intermittent work on open circuit is required. For this work even, in many places, the ordinary gravity cell is constantly taking the place of the Leclanche cell. Also some of the various forms of dry battery which are coming forward at the present time are being experimented with for this work, and especially is the dry battery being used where it is necessary to transport the battery, as on the call bells in cars. The Leclanche cell, as is well known, is a carbon-zinc cell—that is, one pole is carbon and the other zinc. There are various modifications, but in general the carbon pole is surrounded with crushed coke and black oxide of manganese, and contained in a porous cell. This cell is placed in a somewhat larger glass cell, which glass cell contains the zinc pole, the space between being filled with a solution of sal ammoniac or chloride of ammonium. Of late years the porous cell has been removed ; what was originally the carbon pole being made of crushed carbon and binoxide of manganese pressed into a solid mass with some binding material. The pole thus formed is then placed in the chloride of ammonium solution, alongside of the zinc, but separated from it. The Leclanche batteries are mostly bought with the carbon pole already prepared, and consequently our specifications have to do with the zinc and sal ammoniac. The same zinc is used to make the Leclanche poles that is used for the gravity cells, the only difference being that they are cast in rods, about $\frac{5}{8}$ in. to $\frac{1}{2}$ in. in diameter. The sal ammoniac used in these batteries is purchased on the following specifications :

PENNSYLVANIA RAILROAD COMPANY.

Motive Power Department.

Specifications for Sal Ammoniac.

The material desired under this specification is granulated Chloride of Ammonium [NH_4Cl] as free as possible from every other substance. The fibrous material is unobjectionable, provided it is crushed finely enough.

Shipments will not be accepted which :

I. Are not in the granulated form, or in case the crushed fibrous material is sent, if the pieces are larger than a wheat kernel.

II. Contain less than 65.15 per cent. of Chlorine.

III. Contain less than 31.20 per cent. of Ammonia [NH_3]

THEODORE N. ELY,
General Superintendent Motive Power.

Office of the General Superintendent Motive Power, Altoona, Pa., October 31, 1887.

In our experience, the difficulties with sal ammoniac are largely due to dirt, to oxide of iron, and sometimes to the presence of sulphates, especially sulphates of the alkalies. We accordingly determine the amounts of chlorine and ammonia, the amounts represented by the figures being sufficiently below the theoretically pure material to allow for the presence of about 1.50 to 2.00 per cent. of moisture, and a trace of other impurities. These specifications work very smoothly, except that occasionally a new party, who is not accustomed to furnish material as good as our specifications require, furnishes material which fails to meet requirements.

We determine the chlorine by taking a weighed amount

of the sal ammoniac, dissolving in water, and then triturating with a solution of nitrate of silver of known strength, using chromate of potash as an indicator to determine the end reaction. The ammonia is determined by taking a weighed amount of the material, dissolving in water in a flask, then treating with an excess of caustic potash and boiling. The ammonia is set free and is caught in a standard sulphuric acid solution. A known amount of this solution is taken, and the excess that is not satisfied with the ammonia is determined, the difference giving the ammonia.

With the development of electric light plants along the line, both those under the control of the Company and the local companies furnishing light to the towns, there is quite a disposition to operate telegraph lines with electricity obtained from dynamos. This is believed to work very satisfactorily, and where the electricity can be obtained in this way, it results in great economy. If it is necessary to put in a special plant for the purpose, it would be quite otherwise, since the amount of electricity required to operate telegraph lines is so small. It may be not generally known that the total current required to operate 30 or 40 telegraph lines side by side is not greater in amount than would be required to run two incandescent lamps. The great difficulty with dynamo electricity for telegraph service is that usually in the telegraph service the lines are so long, and the number of instruments are so great, that very high electro-motive force is required, with a very small amount of current. On the other hand, most of the dynamos used for incandescent lighting, at least, are built with moderately low electro-motive force, and with very high capacity. Where the electro-motive force is sufficiently high to overcome the resistance of the telegraph circuit, it is, as said above, very desirable to use this source of electricity, provided it can be obtained from the lighting service. Where the resistance is too great, or where a special plant has to be put in for the purpose, we are inclined to think the batteries will have to be used for a period of time, at least.

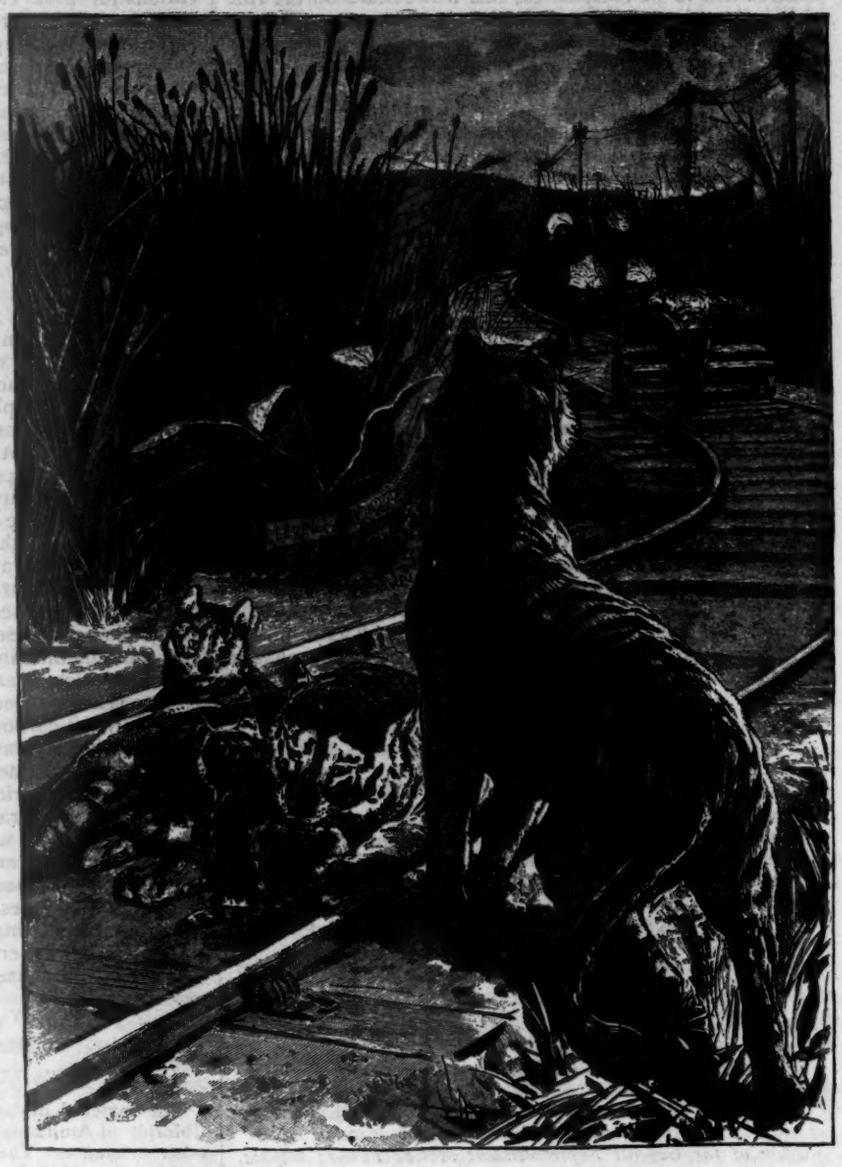
In the next article a discussion of paints will be begun.

(TO BE CONTINUED.)

AN INDIAN ENGINEER'S PREDICAMENT.

THE striking illustration given on this page—which is reduced from the London *Graphic*—shows the unexpected and somewhat startling predicament of an engineer making a little trip of inspection on an East Indian railroad. He has come suddenly upon a little family party which has camped out, without leave, upon the right-of-way, apparently in entire disregard of the claims of the company; he has no automatic brake, and cannot reverse, for his motive power has deserted him.

The predicament, as shown in the picture, is bad enough, but it is on record that the result was *not* a vacancy in the maintenance-of-way department, as might have been expected. Either the family party was conscious of the fact that its members were trespassers, they were frightened at the car, or else they were not hungry, for before the handcar reached them they rose and quietly walked off into the jungle—very much to the relief of their unwilling visitor, who survived to make the sketch from which this drawing was afterward elaborated.



AN INDIAN ENGINEER'S PREDICAMENT.

The artist has drawn the scene graphically enough, but a railroad man *might* make the criticism that the curve which he has put in his picture would be, in real practice, almost as dangerous to a train as the tiger is to the unhappy engineer who confronts him so unwillingly.

THE PROPOSED LONDON TOWER.

SOME time since the Tower Company, of London, advertised for designs for a tower, the height of which was intended to exceed considerably that of the Eiffel Tower—984 ft.—and which was to be used substantially for the same purposes—that is, as a point from which visitors could obtain a very wide view and to which they would be attracted for that purpose, and which would be a marked point for all sightseers. Prizes of $2,500 and $1,250 were offered for the best and second best designs, and the decision was to be made by a jury of engineers.

In response to this offer 68 designs were sent in, of very

varying merit, some of them being, as the Jury stated in its report, "wildly eccentric or extravagant, while others were marked by an entire absence of architectural merit." In fact, the Jury say, "We must confess to a feeling of disappointment on the whole as to the result of the competition, there being no single design which we could recommend as it stands for execution. In justice to the competitors it must be remembered, however, that the existence of the Eiffel Tower and the desire to avoid imitations necessarily enhanced considerably the difficulties of the problem, because in the Eiffel Tower the most natural and obvious way for combining economical construction and suitable architectural effect had already been appropriated."

The Jury awarded the first prize to the design shown herewith in fig. 1, which was the work of A. Stewart, J. M. Maclaren and W. Dunn, of London. This design is for a tower 1,200 ft. in height, with an octagonal skeleton base 300 ft. in diameter. The tower is to be built of steel throughout, and to have steam elevators running to the top.

The second prize was given to the design shown in fig. 2, which was submitted by John J. Webster and J. W. Haigh, of Liverpool, and which is for an octagonal steel tower 1,300 ft. in height with a base 470 ft. in diameter. Hydraulic elevators are proposed, and the lower part of the tower and the upper platforms are provided with buildings for such purposes as may be desired.

The third design received honorable mention from the jurors, and is shown in fig. 3. It is the work of Max am Ende, of London, and presents a design for a tower 1,550 ft. in height, of the Gothic school of architecture and constructed of steel, with a platform 1,000 ft. above the ground, which is treated as the principal one, and upon which the upper part of the tower is constructed. The elevator consists of a train of carriages moving between vertical guides, while a driving carriage below the train runs upon a spiral railroad, having a grade of 1 in 5½. Elevators may be placed in one or all of the four main columns.

For the engravings given we are indebted to *Industries*. From the appearance of the three *best* designs it seems as if the jurors' criticism was fully justified.

We must admit, however, as the jury did, that to make an original design combining structural strength and architectural elegance is no easy task, and perhaps the plans submitted are as good as might have been expected.

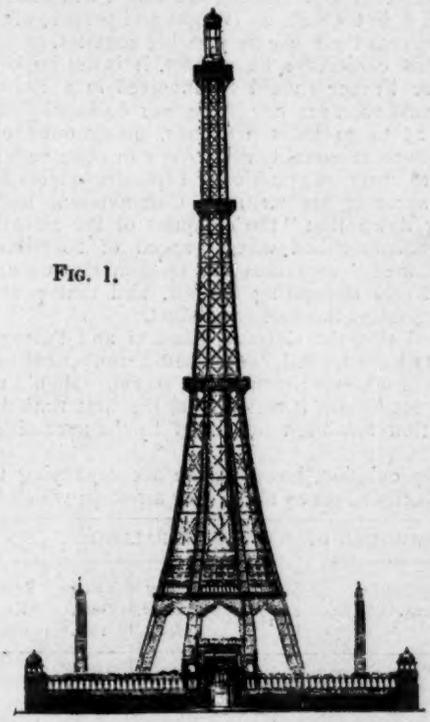


Fig. 1.

Fig. 2.

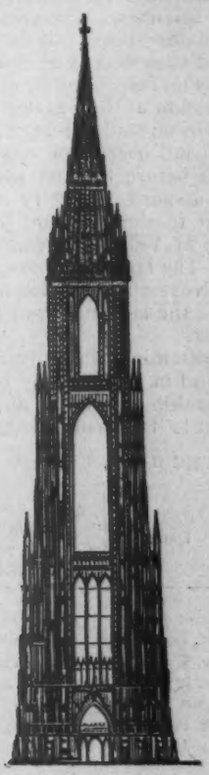


Fig. 3.

AERIAL NAVIGATION.

By O. Chanute, C.E., of Chicago.

(A lecture to the students of Sibley College, Cornell University; delivered May 2, 1890.)

(*Continued from page* 318.)

FRENCH WAR BALLOON, 1884–1885.

The aeronautical establishment of the French War Department, at Calais, was reorganized in 1879. There had been a similar establishment under the first French Republic, which had rendered some service by observing the enemy from captive balloons, but it had been disbanded. The new organization, which was chiefly intended to manufacture and man captive balloons, was in charge of able men, who had sufficient means to experiment, and the advantage of knowing all that had been accomplished by their predecessors. Giffard had pointed out the path, Dupuy de Lôme had gone into the mathematics of the question in an elaborate memoir, and Tissandier had exhibited the advantages of electric motors. The French officers in charge, Messrs. Renard and Krebs, improved very greatly upon all previous practice, and built, in 1884, an elongated balloon 165 ft. long by 27½ ft. in diameter, in which the largest section was no longer placed midway of the spindle, as in all previous attempts, but toward its front end, as obtains in the case of birds and fishes. Moreover, they placed the screw in front instead of behind, as previously practised; but the great improvement consisted in largely increasing the energy of the motor in proportion to its weight. Besides this, they obtained stability and stiffness by the use of an internal air bag and a better mode of suspension, and they enclosed the whole apparatus in a shed, so that it might be kept permanently inflated and await calm days for experiment.

This air-ship, which was named *La France*, held 65,836 cub. ft. of hydrogen, and its lifting power was 4,402 lbs. The car was very long (105 ft.), in order to equalize the weight over the balloon and yet admit of both being placed close together, in order to bring the propelling arrangements as near the center line of gravity as possible. The screw was placed on the car; it was with two arms, and 23 ft. in diameter. The power of the motor was ascertained by experiment in the shop to amount to 9 H. P.,

and speeds of 17 to 20 miles per hour were expected with 46 revolutions of the screw. Fig. 4 represents this air-ship.

The first trial was made on August 9, 1884, and on a calm afternoon the balloon ascended, proceeded some 2½

Fig. 4.

miles from the shed, and returned to its original starting-point, having proved perfectly manageable, and attained a speed of 10¼ miles per hour. This was the first time that a navigable balloon had returned to its landing, and the experiment attracted great attention on account of it being, a few days thereafter, presented to the French Academy of Sciences. The aeronauts believed they could make still greater speed, but for obvious reasons they jealously guarded such details of construction as were not apparent from casual inspection in the air, and more particularly the construction of their motor and battery, concerning which more will be said hereafter.

A second ascension was made on September 12, 1884 (14 days before the last ascension of Tissandier), but although a speed of over 12 miles per hour was attained, an accident to the machine (heating of journals) compelled landing at Velizy, instead of returning to the starting-point. The latter was, however, successfully accomplished again, November 8 following, when two ascensions were made on the same day, and a speed obtained of 13.42 miles per hour.

Various minor improvements were made in the apparatus, and in the ensuing year three more trial trips were taken, making seven in all, on five of which the balloon returned to its starting-point, as follows :

SCHEDULE OF TRIAL TRIPS OF "LA FRANCE."

No. of Trial.	Date.	Rev. of Screw.	Speed, Miles per Hour.	Remarks.
1	August 9, 1884.	42	10.24	Returned to Chalais.
2	Sept. 12, 1884.	50	12.19	Accident—descent at Velizy.
3	Nov. 8, 1884.	55	13.42	Returned to Chalais.
4	Nov. 8, 1884.	35	8.54	" " "
5	August 25, 1885.	55	13.42	High wind ; descent at Villacoubray.
6	Sept. 22, 1885.	55	13.42	Returned to Chalais.
7	Sept. 23, 1885.	57	14.00	" " "

From these experiments, which, it must be remembered, were tried merely to test the efficiency out of doors of a new war engine, Captain Renard, while stating that the resistance was greater and the speed less than he had at first expected, deduced the following formulæ :

$$(1) \qquad R = 0.01685\ D^2\ V^2$$

$$(2) \qquad W = 0.01685\ D^2\ V^3$$

$$(3) \qquad T = 0.0326\ D^2\ V^3,$$

in which

R is the air resistance to motion in kilogrammes.
V " " speed in meters per second.
D " " diameter of the balloon.
W " " work done in kilogrammeters.
T " " " " on the shaft of the screw.

From this he calculates that a balloon 32.8 ft. in diameter would require 43½ H. P. to drive it at 22 miles per hour.

Since 1885 no outdoor experiments have been made so far as the public is aware, but it is understood that numerous experiments have been actively carried on within doors, which, being intended to improve a war engine, have been surrounded with profound mystery.

A year or so ago this policy of secrecy was apparently changed, and Commandant Renard began publishing a number of scientific papers upon various branches of the subject, such as the resistance of air, his experiments with aerial screws, the possibility of success with aeroplanes and the construction of his primary battery, which, after having been kept secret for a time, he now fully describes and figures, with the remark that " this publication now threatens no danger to the national security," from which it is not unreasonable to infer that he has found a more efficient motor, and that it is not electric ; for he says further : " In the actual condition of industrial electricity, it is impossible that an electrical balloon shall constitute a true war engine."

At the Paris Exposition of 1889, the War Department erected a special building, and exhibited the air-ship *La France*, together with all its belongings, including the motor, battery, screw, etc., and full accounts of these exhibits have been published in various technical journals.

And yet the impression was produced on many minds while in Paris, more perhaps from what was not said than from what was shown and published, that the French War Department was, even now, in possession of important improvements and information which will afford increased speed, but which, as is right and proper, are kept secret; to prevent their use by possible enemies.

Should this conjecture be correct, it is not impossible that, in case France should be involved in a European war, we should soon see navigable war balloons flying at the rate of 25 to 30 miles per hour, going out over the enemy's lines on reasonably calm days to observe his positions and to drop an occasional explosive on his head. Indeed, in some of his writings, Commandant Renard, after laying down that " the conquest of the air will be practically accomplished when a speed of 28 miles per hour is obtained," expresses the opinion that we are on the eve of freely navigating the air, and that probably France will possess the first aerial fleet.

It is stated that the German, Russian and Portuguese Governments have recently organized aeronautical establishments, and are experimenting in secret. Should some notable success follow, it will not be the first time that a great invention has been advanced by the necessities of war.

Leaving speculation, however, the accompanying table gives the principal data as to the four air-ships which have

SCHEDULE OF NAVIGABLE BALLOONS.

Data.	Giffard, 1852.	Dupuy de Lôme, 1872.	Tissandier, 1883.	Renard & Krebs, 1884–85.
Length, out to out.....ft.	144.3	118.47	91,84	165.21
Diameter, largest section.... "	39.3	48.67	30.17	27.55
Length to diameter...proportion	3.67 to 1	2.43	3.04	6
Cubic contents.....ft.	88,300	120,088	37,439	65,836
Ascending power..... ..lbs.	3,978	8,358	2,728	4,402
Weight—Balloon and valves, "	704	1,255.5	374	812
" Netting and bands, "	330	396	154	279
" Spars and adjuncts, "	660	1,316.5	75	170
" Rudder and screw, "	....	165	....	193
" Anchor and guide rope..... "	176	308	110	....
" Car complete..... "	924	1,287	220	995
" Motor in working order..... "	462	2,000	616	1,174
" Aeronauts ..... "	154	310	330	308
" Ballast and supplies "	567.6	1,320	849	471
" Total apparatus.... "	3,977.6	8,358	2,728	4,402
H. P. of motor.....	3	0.8	1.5	9
Weight of motor per H. P., lbs.	154	2,500	410	130
Speed obtained...miles per hour	6.71	6.26	6.71	14
H. P. required 25 miles per hour.....	155	52(?)	77	51
Motor lbs. per H. P.....	3	38(?)	8	23

been described, and the H. P. necessary to drive them at 25 miles per hour.

The last line shows how light a motor must be to produce 25 miles per hour without increasing the weight.

We will consider the all-important question of motive power after examining the probable requirements of apparatus heavier than the air.

(TO BE CONTINUED.)

UNITED STATES NAVAL PROGRESS.

THE contract for the tubulous boilers for the coast-defense ship *Monterey*, now under construction at the Union Iron Works, San Francisco, has been awarded to Charles Ward, of Charlestown, W. Va. The contract provides that three-fourths of the power for the vessel shall be furnished by tubulous boilers, and the Ward boiler has been decided upon, after a competitive test. All makers of coil and tubular boilers in the country were invited to submit boilers for this test, but the only competitors were Charles Ward and William Cowles, of New York. Cowles proposed to furnish the required power with six boilers, each having 47 sq. ft. grate surface and 1,998.5 sq. ft. heating surface, and weighing, in steaming condition, 12.65 tons. Ward proposed four boilers, each having 74 sq. ft. grate surface and 2,938 sq. ft. heating surface, and weighing, in condition for steaming, 15.80 tons. The Ward boiler tested was considerably smaller than this. It had 53 sq. ft. grate surface and 2,473.5 sq. ft. heating surface, the ratio of heating surface to grate surface being 46.67 : 1. In the Cowles boiler this ratio was 43.12 : 1.

The trial lasted 24 hours, the boilers being worked at 160 lbs., with 2 in. air pressure in the fire room. The trial board, of which Chief Engineer Loring was senior member, spoke very highly of the performance of both boilers, but found that the Ward boiler was best fitted for use in the *Monterey*. The four boilers will supply about 4,500 indicated H.P. The rest of the steam for the vessel will be supplied by two ordinary navy boilers, to be built by the contractors. A description of the Ward boiler will be found on pages 347 and 348.

TRIAL OF THE "PHILADELPHIA."

The official trial of the new cruiser *Philadelphia* took place June 26, the run being made over a 40-mile course marked out off Long Island, between Southampton and Block Island.

The vessels detailed to mark the course for the *Philadelphia* and to make current observations during the trial were ordered to arrange themselves as follows: On the range at west end of the 40-mile course, off Southampton, L. I., the *Dolphin*, and at intervals of ten miles the tug *Nina*, the coast survey steamer *Blake*, the *Petrel*, and last the *Essex*, at the east end of the 40-mile course, off Block Island. Current observations were to be made from each of these vessels every ten minutes during the four-hour trial and at the instant the *Philadelphia* passed. The different ships, owing to a fog, were unable to take their exact positions. The time required to turn beyond the end of the course before beginning the return run was to be thrown out, and only the time taken in running over the straight course was to be considered in estimating the speed.

At 12 h. 48 m. 26 s. the *Philadelphia* started on her course. The end of the first half of the run showed the elapsed time to be since the start 2 h. 6 m. 23 s. The exact distance run was 40.146 miles and the average speed over the course was therefore at the rate of 19.1 knots per hour. Only the two straight runs over the course were considered; but no change in the speed of the engines was allowable, and all the other conditions of the trial were continued during the turn.

The westward run over the course was made in 2 h. 0 m. 32 s., making the total time for the two runs, 80,292 miles in all, 4 h. 6 m. 55 s.; the apparent rate of speed was thus 19.512 knots an hour, or more than half a knot above the contract requirements. It is understood that the average boiler pressure during the run was 155 lbs. and the engines averaged 120 revolutions per minute.

The official statement makes the average speed for four hours' run 19.678 knots—or 22.65 miles—per hour, the engines and boilers working in a most satisfactory manner.

BIDS FOR NEW SHIPS.

The Navy Department announces that bids will be received until October 1 for four new ships, designated as "Coast-Line Battle-Ships Nos. 1, 2 and 3" and "Cruiser No. 12." These bids may be made for the ships on the Department plans complete, or on the builder's plans for either hulls or machinery. The battle-ships are to be completed within three years; the cruiser within 2½ years. Bids may be made for two battle-ships, or for one battle-ship and one cruiser; but no single bid will be received for more than two of the ships.

The plans are not yet fully completed, but were to be ready by August 1, when full specifications could be obtained by bidders.

The general plans are so far ready, however, that it may be stated that Cruiser No. 12 will be of 7,300 tons displacement and have a speed of 21 knots; a premium of $50,000 for each quarter knot over, and a penalty of $25,000 for each quarter knot below that speed are provided. The hull is to be of steel, not sheathed. An armored deck is to extend all fore and aft, being turned down on each side to meet the side of the vessel below the water line, having a maximum thickness of 4-in. over the engine and boiler spaces. An approved water-excluding material equal to woodite or cellulose is to be fitted along the sides forward and aft on the slopes of the protective deck. The electric-lighting plant should consist of three units, each unit having an engine, dynamo, and combination bed plate, the weight of which should not exceed 24,000 lbs. The weight of all fittings and stores of the installation, including search lights, should not exceed 30 tons. A conning-tower, with 5 in. armor, is to be fitted. The main battery is to consist of four 6-in. rifled guns, to be mounted in the open protected by heavy shields, weighing two tons each; eight 4-in. rapid-fire guns, mounted under the protection of the upper deck, having fixed segmental shields attached to hull four inches in thickness. Secondary battery to consist of twelve 6-pounders, six 1-pounders and two machine-guns. Two of the 1-pounders and one of the machine-guns are to be mounted on field carriages. There are to be four torpedo-tubes and discharging apparatus and 12 torpedoes. The coal capacity is to be 750 tons on 23 ft. draft. There are to be two masts with signal poles. The cost is not to exceed $2,750,000, excluding guns, ammunition, armor of turrets, barbettes, gun shields and armored tubes directly pertaining to the protection of the guns and loading positions.

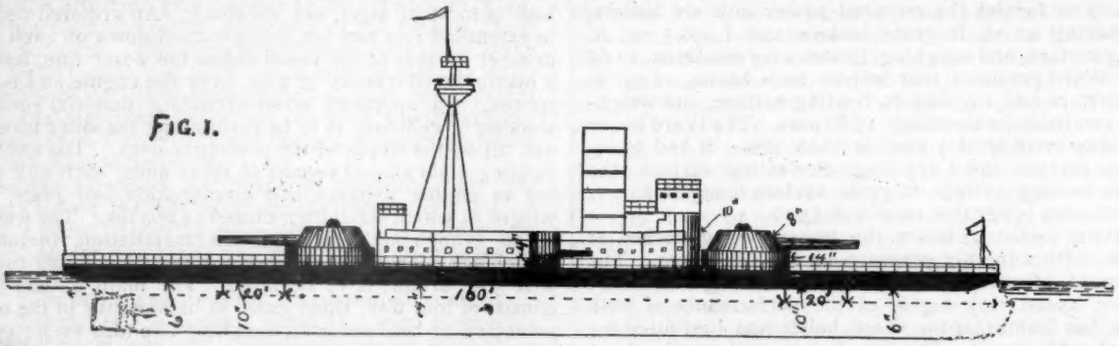
The coast-line battle-ships are to be about 9,000 tons displacement, and are to have a speed of 15 knots an hour, with premium of $25,000 and penalty of the same amount for each quarter knot above or below that speed. The hulls are to be of steel, with bracket framing; the armor belt is to be not less than 17 in. thick and 7 ft. wide. The transverse armor at the ends of the belt will be not less than 14 in. in thickness. The redoubts and turrets will have armor not less than 17 in. thick. The side from armor belt to the main deck will be protected by not less than 5 in. of steel armor. Coal is to be carried back of this 5-in. armor. An armored deck not less than 3 in. in thickness is to extend fore and aft from the ends of the armor belt, being curved down on each side to meet the side of the ship below the water. Over the side armor belt this steel will be not less than 2¼ in. in thickness. An approved water-excluding material equal to woodite or cellulose is to be fitted along the sides fore and aft on the slopes of the 3-in. protective deck. The battery to be carried is as follows: Four 13-in. breech-loading rifles, with their mounts and equipments; four 8-in. breech-loading rifles, with their mounts, shields and equipments; four 6-in. breech-loading rifles, with mounts, shields and equipments; sixteen 6-pounder rapid-fire guns; six 1-pounder rapid-fire guns and two gatlings, with all the necessary mounts and shields therefor. The 13-in. guns are to be protected by armor not less than 17 in. in thickness. The axes of the guns are to be not less than 6 ft. above the deck, and due regard must be paid to interference of fire and the effects of the blasts of the various guns. The 6-in. and 8-in.

guns will be protected by shields, but are to be protected in addition by barbettes, or otherwise carrying 4-in. armor for the 6-in. guns and 6-in. armor for the 8-in. guns, and the ammunition of the latter guns is to be supplied through armored tubes. Twelve torpedoes will be carried. There will be seven above water torpedo tubes, two forward, one aft, and two on each side. There will be a military mast, and a conning-tower protected by 10-in. plate. The coal capacity must be 400 tons on 24 ft. draft. An electric lighting plant is to be provided.

THE COAST-DEFENSE RAM.

Plans are being prepared for the coast-defense ram, of the type designed by Admiral Ammen. The total weight of armor on this vessel is estimated at about 770 tons, the greatest thickness being on the conning-tower, which will be 18 in.; deck armor will be 3 in. at center and 6 in. on the side; the upper side armor 6 in. and the lower 3 in. The general dimensions are: Extreme length, 243 ft.; breadth, 43 ft. 6 in.; breadth at water-line, 40 ft. 6 in.; extreme depth, 21 ft.; mean draft, 15 ft. 6 in., which can be increased to 17 ft. 6 in. The displacement at ordinary draft will be 2,160 tons, or at 17 ft. 6 in. draft, 2,530 tons. The engines will have 4,800 H.P., and the estimated speed at full power is 18 knots an hour.

FIG. 1.



THE DEVELOPMENT OF ARMOR.

By First Lieutenant Joseph M. Califf, Third U. S. Artillery.

(Copyright, 1889, by M. N. Forney.)

(*Continued from page* 302.)

XIV.—RECENT PROGRESS IN THE UNITED STATES.

The Italian armor trials at Spezzia, in 1876, closed the first epoch in the development of armor. The superiority of the hard-faced over the wrought-iron armor plate was so clearly demonstrated by these experiments that the latter was, as if by the common consent of the armor-makers of the world, abandoned. With scarcely an exception, every iron-clad laid down since that date has been provided with either steel or steel-faced armor.

For 10 years after the close of the Civil War no steps were taken toward the building of iron-clad ships of any kind. The war had left us with a large number of the monitor type of iron-clads, together with the *New Ironsides* and the *Roanoke*. The former was burned at League Island soon after, and the latter disappeared from the Navy list in 1883. Leaving out of account the Western river flotilla, a greater part of which disappeared with the ending of the war, the formidable list, so far as numbers went, of our iron-clad fleet then upon the rolls, had, at the end of the first decade, been reduced one-half.

Upon this list were five double-turreted monitors destined to become the subject of much controversy and of many reports, and of various attempts to improve and rebuild, and finally to figure, in name at least, among the modern iron-clad fleet of the country. These were the *Puritan*, *Miantonomoh*, *Monadnoc*, *Amphitrite* and *Terror*. Built originally of wood their rapid deterioration followed as a matter of course. In 1874–5 it was decided either wholly or substantially to rebuild them, giving them iron hulls.

The work of restoring these vessels went on so slowly, however, that in 1882 an Act of Congress made it obligatory upon the Naval Advisory Board to report as to the wisdom and expediency of completing them. So strongly in favor of completion was this report that work upon them was resumed at once and they were launched in the following year. In the new constructions the central spindle of the original monitors, about which the turrets revolved, disappeared, and rollers under the base of the turret were substituted.

The Act of August 5, 1882, marks the first step taken in the United States looking to the employment of modern armor. This act provided for the building and fitting the turrets and pilot-house of the double-turreted monitor *Miantonomoh* with steel-faced armor. In the absence of any establishment in the United States capable of turning out armor plates of this description, recourse was had to foreign manufacturers, as had to be done in the case of steel forgings for heavy guns, and bids were invited. In November of the following year contracts were entered into with the firms of John Brown & Company and Charles Cammell & Company, of Sheffield, for compound armor plates for the turrets, pilot-house and armored stack of this vessel—the 7-in. iron side armor remaining as it was—all of which were delivered within the eighteen months following.

By March, 1885, the completion of the four remaining double-turreted monitors was well under way, and in the following year the construction of an armored cruiser and an armored battle-ship was provided for. The large amount of armor plate called for by the appropriations of these two years was a direct challenge to American metal-workers, as they were, by the terms of the acts of Congress, to be given preference, "provided contracts for furnishing the same in a reasonable time, at a reasonable price, and of the required quality can be made with responsible parties."

In response to the invitation for bids from home manufacturers for steel armor plates the Bethlehem Iron Company was, in June, 1887, awarded the contract for supplying the 6,700 tons for these six vessels, the delivery to begin two and one-half years from date of contract.

From this date—June, 1887—a supply of armor plate, as well as of forgings for heavy guns, of domestic manufacture was guaranteed, and since March, 1885, no contracts have been made abroad for either gun forgings or armor. The Bethlehem plant is now in working order and is one of the most complete establishments of its kind in existence, with hydraulic forging presses, heavy hammers, machinery and tools capable of turning out forgings for guns up to 16-in. caliber, and of steel armor plate of any required thickness.

It should be stated here that in the circular issued by the Navy Department in 1886, to the steel manufacturers of the country, it declared for steel armor. This decision was in accordance with the recommendations of the Gun Foundry Board of 1884, the Fortification Board of 1885, and the Senate Select Committee on Ordnance and War-Ships, whose investigations at home and abroad extended over both of these years.

The *Miantonomoh*, the first modern armored United States vessel, now about completed, is a low-freeboard, twin-screw iron-clad of the monitor type, with two roller-base turrets, each to mount two 10-in. breech-loading rifles. The turrets are protected by 11½-in. compound armor—one manufactured after the Ellis, the other after the Wilson patent. Her side armor is of iron. An armor belt, 6 ft. in depth extends the entire length, protecting all parts of the vessel, 2 ft. above and 4 ft. below the water-line, and has a thickness of 7 in. amidships, reduced to 5 in. at the ends. On top of the side armor an armored deck, 1¾ in. in thickness is worked for the whole length of the vessel. On top of the turret is placed the pilot-house, 9 in. in thickness. The smoke-stack is protected by 10½ in., and the ventilator by 9 in. of armor. A hurricane deck, well above water, connects the two turrets.

The armor of the other four double-turreted monitors is to be wholly of steel. According to the original plans the *Puritan* did not materially differ from the *Miantonomoh*, except as to the character, depth and thickness of her armor. These plans have since been revised and greatly changed. Instead of four 10-in. guns mounted in two roller-base turrets, the new *Puritan* will have the same number of 12-in. rifles mounted in barbette-turrets, and the high, light hurricane deck is replaced by a solid superstructure built between the barbette-turrets, affording room for offices and officers' quarters, and within and on top of which the secondary battery is mounted. The armor belt is 5 ft. 7 in. in depth, with a maximum thickness amidships of 14 in., to a point 12 in. below the water-line, and thence tapering to 6 in at the armor shelf, and for a length of 160 ft.—sufficient to give protection to the engines, boilers, magazines, etc. Forward and abaft of the central section for 20 ft. the armor is reduced to 10-in. in thickness, tapering to 6-in. at the bow and stern. This armor is strongly backed with wood and strengthened by rigid frames and girders. The guns are to be mounted on turn-tables within fixed barbettes having 14-in. steel armor upon an 8-in wood backing. Sloping turn-table shields of steel, 8 in. in thickness, inclose the guns and afford protection to the gunners. The guns of the secondary battery mounted on the superstructure are protected by 4-in. armored barbettes, built in as a part of this structure; those on top are provided with 2-in. gun shields.

The pilot-house, containing the steering gear, speaking tubes, etc., is immediately abaft the forward barbette, and is provided with 10-in. steel armor. The main deck is protected with two thicknesses of 1-in. plating. The distribution of armor on this vessel is shown in fig. 1.

The *Amphitrite* is to be finished upon substantially the same plans adopted for the *Puritan*. The plans upon which the *Monadnoc* and *Terror* are to be completed have not, so far as I am aware, yet been announced.

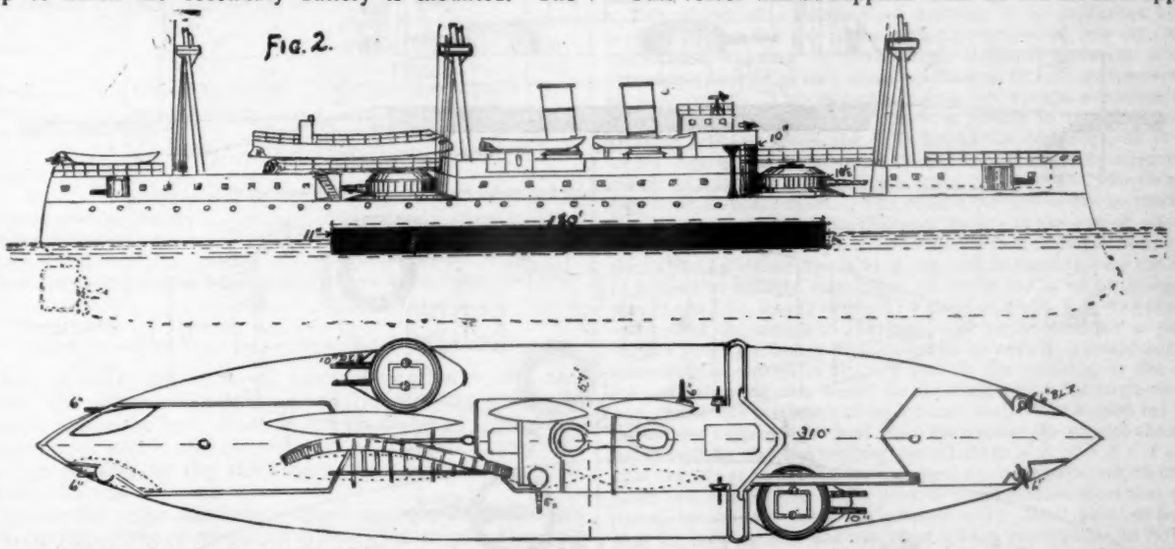
The most decided as well as the most important step taken by the United States in the building of iron-clad ships was authorized by the Act of August 6, 1886, wherein the building of an armored cruiser and an armored battle-ship, each of about 6,000 tons displacement, was provided for. The keels of these vessels were laid down last year, the former at the Brooklyn and the latter at the Norfolk Navy Yard. Both are now well under way, and as the pioneers of American iron-clad ship-building deserve brief mention.

The disposition of the armor on the armored cruiser, the *Maine*, is shown in the accompanying cuts, fig. 2. A water-line belt of vertical armor, extending 180 ft. amidships, affords protection to the vitals of the ship, with a depth of 7 ft.—3 ft. above and 4 ft. below the water-line. This has a thickness of 11 in. from the top to 1 ft. below the water-line, tapering from thence to 6 in. at the armor shelf, upon a backing of 8 in. of wood. The ends of the armor belt are connected by athwartship armor-bulkheads 6 in. in thickness.

The four 10-in. rifles of her main battery are to be mounted in revolving turrets, and protected by 10½ in. of steel armor. The bases of these turrets are to be further protected by oval-shaped fixed breastworks of the same material and thickness. The conning-tower will have 10 in. of armor, and to protect the steering gear, etc., an armored tube leading thence to the armored deck is to be provided. This armored deck will slope from the top of the belt at its after end, the slope being 4 in. thick. The under-water deck at the end will be 2 in. thick, protecting magazine and steering gear.

This vessel will be supplied with all the modern appli-

Fig. 2.



ances in the way of steam steering gear, self-stowing anchors and electric lights. In addition to her armament she is to carry two 60-ft. torpedo boats.

Fig. 3 gives, in a general way, the disposition of the armor on the battle-ship—the *Texas*. A steel armor belt, 12 in. in thickness will protect the vital portions of the ship, extending 2 ft. above and 4½ ft. below the water-line. This belt is to terminate at each end in a 6-in. steel breastwork, backed by 6 in. of wood, and extending diagonally across the vessel. A protective deck, 3 in. in thickness, is to be worked over the belt sloping down from the ends of the belt to the bow and stern. Each of the two 12-in. rifles of her main battery will be mounted in a revolving turret, 12 in. in thickness. The lower ports of these turrets, as well as the machinery necessary for working the guns, are to be inclosed in armored redoubts of the same thickness as the turrets. The conning-tower is likewise to have 12-in. armor, the ammunition hoists, 6-in. The six 6-in. guns of the secondary battery are protected by steel shields.

In addition to the *Maine* and the *Texas*, appropriations for the following armored vessels have been made: An armored coast-defense vessel of 4,000 tons; an armored cruising monitor of about 3,100 tons; a ram for harbor defense of 2,000 tons; an armored cruiser of 8,100 tons, and to this list has been added under the Appropriation Bill of the present year, three battle-ships. Of these, contracts for the armored cruiser and for the coast-defense vessel have already been made, and work upon the latter

has been begun by the Union Iron Works, San Francisco. The coast-defense vessel, designed under the direction of Secretary Whitney, is to be of low-freeboard, much after the type of the monitors, to be heavily armored and to carry a battery of one 12-in. and one 16-in. rifle in two fixed barbettes. The vessel can be submerged 18 in. for action. A belt of armor with a thickness of 16 in. amidships will protect the machinery, boilers and magazines, tapering to 6 in. at the bow and stern. The armor on the barbettes will be 16 in. for the 16-in. and 14-in. for the 12-in. gun. These barbettes will afford protection for the turn-tables, gun-slides, elevating and hydraulic gear, but, as in all barbette batteries, give no protection to the guns themselves and very little to the men who serve them. The pilot-house, smoke-pipes and tube for steering apparatus will be protected by 10-in, 6-in. and 6-in armor respectively.

The armored cruising monitor, commonly known as the "Thomas monitor," differs from the ordinary vessels of this type in having a turtle-back deck, and by an arrangement of tanks into which water can be admitted, so that her cruising freeboard may, for action, be reduced 3 ft. The arched deck of steel will have a thickness of 3 in. at the crown, turning downward at the sides to 4 ft. below the fighting-line, and increasing in thickness to 4½ in. at the edges. The two 10-in. guns of her main battery will be mounted in a 10-in. roller-base turret. The base of the turret will have the further protection of a fixed breastwork of the same thickness. An elliptical bulkhead of 10-in. armor, rising from the armor-deck, affords protection to the air-pipes, ventilators and ash-hoists. A steel shield will protect her single 6-in. rifle. A secondary battery of rapid-fire guns with a 15-in. pneumatic dynamite gun, and two under-water torpedo-tubes, for firing torpedoes by gunpowder impulse, will complete her armament.

The armored cruiser, which with her 8,100 tons displacement approaches very closely to a battle-ship, will rely for protection against an enemy's shot more upon horizontal than vertical armor. The protective deck of steel will have a maximum thickness of 6 in. on the slope and 3 in. at the crown. This deck will be 1 ft. above the water-line amidships and slope to 5 ft. below water at the sides. The pilot-house, ammunition-hoists, etc., will be well protected, while the four 8-in. rifles of her main battery are to be mounted in 10-in. barbette turrets, and the guns of the secondary battery will be behind shields of an average thickness of 4 in.

The three battle-ships, for whose construction the Secretary of the Navy invited proposals within 24 hours after the approval of the Appropriation Bill by the President, will, when finished, compare very favorably, in armored protection and in armament, if not in tonnage, with the latest constructions in foreign services. The Act of Congress, under whose provisions these vessels are to be built, says, that the President is "authorized to have constructed by contract three sea-going coast-line battle-ships, designed to carry the heaviest armor and most powerful ordnance upon a displacement of about 8,500 tons . . . and to have the highest practicable rate of speed for vessels of their class, to cost, exclusive of armament and of any premiums that may be paid for increased speed, not exceeding $4,000,000 each."

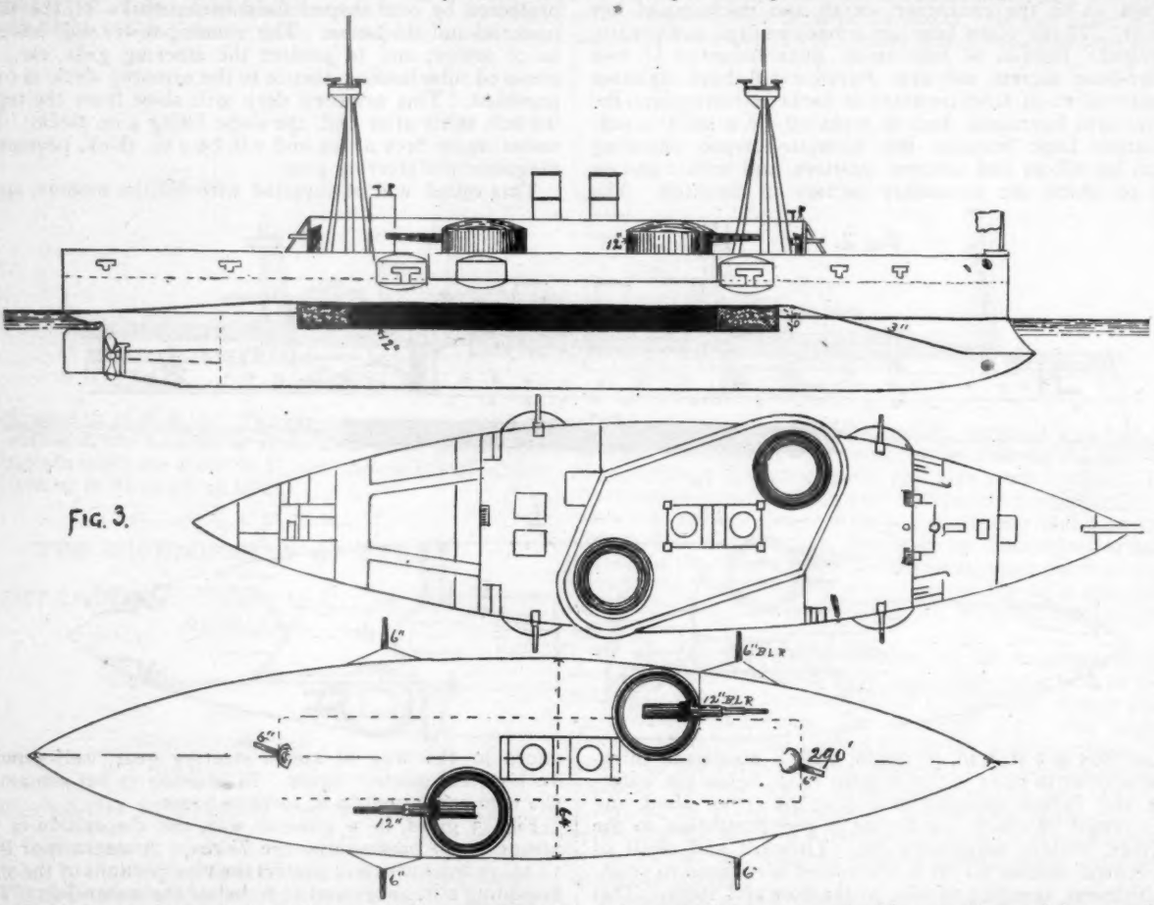


FIG. 3.

Briefly stated, their armor-protection is to consist of a 7-ft. water-line belt of a maximum thickness of not less than 18 in.; the transverse armor at the ends of the belt of not less than 14 in.; the redoubts and turrets of not less than 17 in., and the sides above the belt to have not less than 5-in. steel armor; the deck armor is of 3 in. Coal protection and cellulose backing are also provided for. The armament will consist of four 13-in., 60-ton breech-loading rifles, four 8-in. and four 6-in. rifles, besides rapid-fire and machine-guns. In addition seven above-water torpedo-tubes are stipulated for.

It may be interesting to compare these vessels with the eight new battle-ships which the British Board of Admiralty decided upon building last November, and which are now under construction. Except in the matter of tonnage they approach very closely. Against the 14,000 tons displacement of the English ships ours have only 8,500, but the

guns of their main batteries are the same in number and of about the same caliber, with a slight advantage in favor of the English; but, as regards their secondary batteries, the ten 6-in. guns on each of the British ships are brought in comparison with the four 6-in. and four 8-in. on our own, with the number of quick-firing and machine-guns about equal, leaving with us a decided superiority in weight of metal. In the matter of armored protection each has

Name.	Type.	Condition.	Displacement, Tons.	Steel Armor. Ins.	
				Side.	Turret and Barbette.
Puritan	Low-freeboard turreted barbette	Awaiting completion	6,060	14	14
Amphitrite	Low-freeboard turreted barbette	Awaiting completion	3,815	8	11½
Monadnoc	Low-freeboard turreted barbette	Awaiting completion	3,815	8	11½
Miantonomoh	Double-turreted monitor	Awaiting completion	3,815	7*	11½
Terror	" " "	Awaiting completion	3 815	7	11½
Texas	Armored battle-ship	Building	6,314	12	12
Maine	Armored cruiser	"	6,648	11	10½
No. 2	" "	Contract awarded	8,100	†	10
Coast-defense vessel	Low-freeboard barbette	Building	4,000	16	16 14
Cruising monitor.	Monitor	Plan not ready	3,100	5	10
Harbor-defense ram		Not yet designed	....	...	.....
Three battle-ships	Armored battle-ships	Not yet begun	8,500	18	17

* Wrought-iron.

† Thickness of side armor not yet decided upon, but will be light.

18 in. of side and 17 in. of turret or barbette—the one steel, the other compound—as well as the 5-in. steel side armor above the belt, while in the thickness of the underwater deck and in the employment of coal, etc., for auxiliary protection to the machinery, the stipulations are almost identical.

In the five years that have elapsed since the United States entered upon the construction of iron-clad ships a showing has been made not at all discreditable. But it has been a beginning only, for as yet not a single armor-clad is in commission. The *Miantonomoh*, guns and all, is, however, very near completion. The five protected cruisers now in commission are, strictly speaking, armored ships, the armor being applied horizontally upon their decks instead of vertically upon their sides, but they are not so classified upon the Navy lists. The largest of them, the *Baltimore*, has an armored deck 2½ in. on its horizontal part and 4 in. on the slope. The conning-tower is built of 3-in. steel.

Herewith is given a list of the armored vessels for which appropriations have already been made. In addition to this list are the thirteen single-turreted monitors, which have been the subjects of numerous official investigations and reports, both favorable and otherwise, but which still remain upon the lists awaiting final action. Their 5 and 11-in. side and turret armor of wrought-iron is so inadequate to withstand the blows of modern projectiles that, as they stand, they can hardly be considered in counting the effective armored strength of the country.

(TO BE CONTINUED.)

THE ESSENTIALS OF MECHANICAL DRAWING.

By M. N. Forney.

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(*Continued from page* 328.)

CHAPTER IV.—(*Continued.*)

GEOMETRICAL DRAWINGS.

The object of a mechanical drawing is to represent upon a plane surface the true form and proportions of one or more mechanical objects. It differs from ordinary drawing, which represents objects as they *appear* to the eye, or in "perspective," as it is called. This *appearance* does not always represent objects as they really are. Thus, if a person is standing on a straight railroad track, the rails appear to converge, or to be closer together in the distance than they are near to the observer, when, as a matter of fact, it is known that they are everywhere the same distance apart. The reason for this is due to the fact that light is reflected from different points to the eye of an observer in converging rays. To illustrate this, it will be supposed that a person whose eye is at *A*, fig. 108, is looking into the end of a piece of straight metal pipe, *P*, which is shown as though it was cut in half lengthwise. If a pane of glass, *p p*, was placed in front of the mouth of the pipe, and he should draw or paint on this glass the image of the pipe as he sees it, it would appear somewhat as shown in fig. 109, that is, the opening at the end *b b* nearest to his eye would be represented by the large circles and that at the farthest end by a small one. The reason for this is that the rays of light pass from the ends of the pipe to the eye, as shown by the converging dotted lines *A b*, *A b A c A c*, so that the image produced on the glass by these rays, which come from the farthest end of the pipe, is much smaller than that produced by the rays from the nearest end. Most persons know that by looking into the mouth of a long tunnel that its farther end appears like a mere speck, and the rails appear to unite in a point. This diminution in the size of distant objects is, of course, in appearance only. As mechanical drawings are intended to give an absolutely correct representation of the size of objects, in such drawings the rays are supposed to pass from them to the paper on which they are drawn in parallel lines. Thus, if we were making a mechanical drawing showing an end

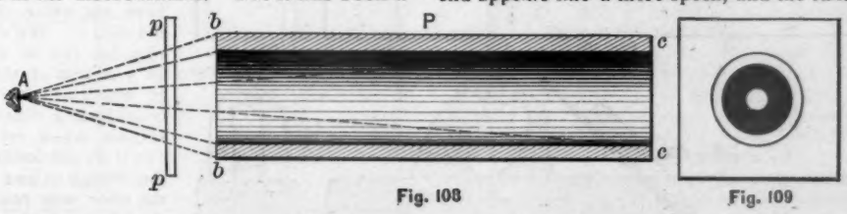


Fig. 108

Fig. 109

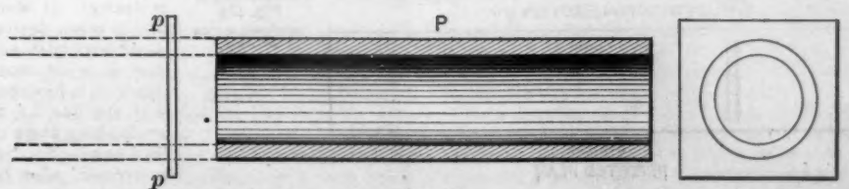


Fig. 110

Fig. 111

view of the pipe *P*, fig. 110, the rays of light would be supposed to pass in straight parallel lines from it to the glass *p p*, as indicated by the dotted lines. If this were the case the farthest end of the object would appear as large as the one nearest to the glass or paper, as shown in fig. 111. Such a view is, of

Fig. 112.

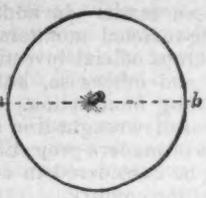


Fig. 113.

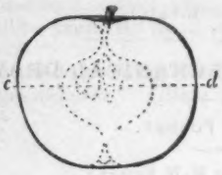


Fig. 115.

Fig. 114.

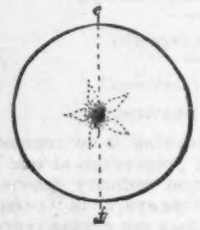


Fig. 116.

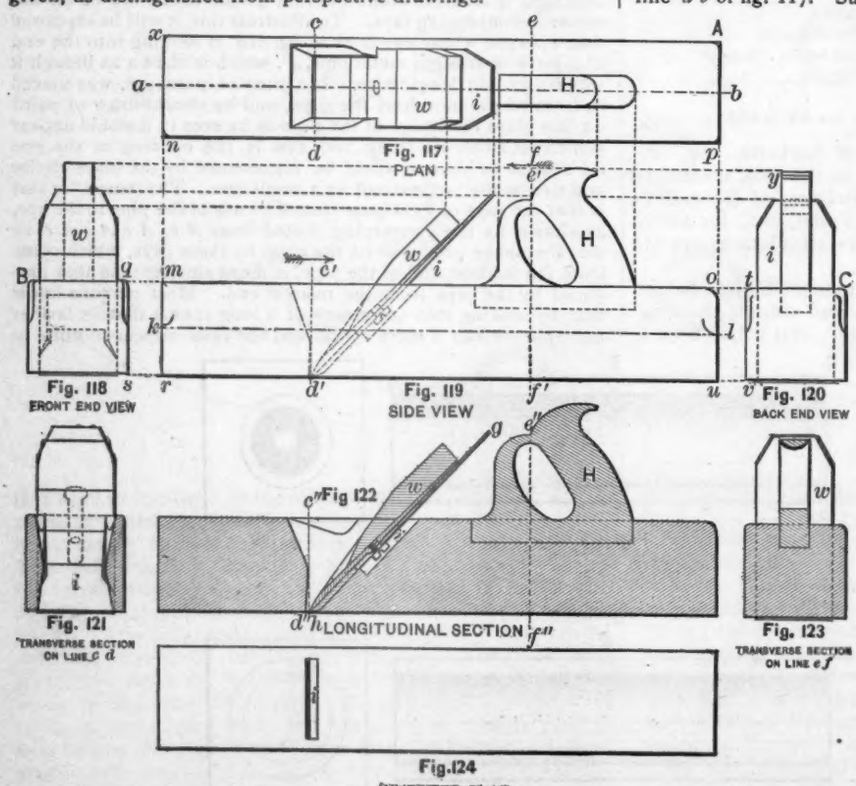
course, purely imaginary, but it serves the purpose of representing objects in their true form and proportions, which is very essential if the drawings are intended—as they usually are—to guide some one in making that which is represented. To all such drawings the general title of *geometrical drawings* is given, as distinguished from perspective drawings.

To give a complete idea of the form and proportions of an object, it is often important to give several different views of it. Thus, if we were drawing an apple and wanted to show it as it appears when looking at it from one side, it would be as shown in fig. 113, which is called a *side view*. If we represent it as it would appear if we were above it and looking down on it, it would be shown in fig. 112, which is called a *top view* or *plan*, and if the apple were turned upside down and represented in that position, as in fig. 114, the drawing would be called an *inverted plan*.

If we want to show the inside of the apple, say the seeds and core, we could represent it as it would appear if cut in half vertically, as shown by fig. 115, which is called a *section* or *sectional view* of the apple. It is evident, too, that it might be desirable to show the arrangement of the seeds as they would appear if the apple was cut through in the other direction, say on the line *c d*, fig. 113, and as shown by fig. 116. There are, therefore, two kinds of sections: one, fig. 115, in which the object is supposed to be cut through vertically, and therefore called *vertical sections*; the other, fig. 116, in which the object is supposed to be cut through horizontally, and therefore called a *horizontal section*, or *sectional plan*. In order to distinguish the parts which are represented as though they were cut in two from those whose surfaces only are represented, it is customary to shade sectional views with parallel lines, as shown in figs. 115 and 116. Sectional surfaces are also sometimes represented by solid black surfaces, or in drawings, by colors, as will be described in a future chapter.

It is often desirable in drawings to show on an exterior view of a machine or other structure some internal parts which would be hidden from view in the object itself. In such cases the interior parts are represented by dotted lines in mechanical drawings. Thus, to show the position and form of the seeds of the apple in figs. 113 and 114, they are represented by dotted lines.*

The appearance of any object, whether it be an apple or a piece of mechanism, of course depends upon our position in relation to it. Thus, fig. 119 represents a side view of an ordinary carpenter's plane. Obviously we can look at this plane from the top and represent it as shown in fig. 117, which, as explained, would be a top view or *plan*; or we might look at the front end of it, as shown in fig. 118, which is a *front view* or *front elevation*; or at the back end, as represented in fig. 120, which is a *back end view* or *rear elevation*. If it is desired to show the construction and arrangement of the interior parts, as the bit *i* and wedge *w*, we can show the plane as though it was cut in two lengthwise on a vertical plane coinciding with the line *a b* of fig. 117. Such a view is shown by fig. 122, and is called a *longitudinal section*. To show the internal parts more perfectly, it might be desirable to show as though it was cut in two crosswise at one or more points. Thus, to show the form of the bit *i* and wedge *w* it may be supposed that the plane is sawn apart on the line *c' d'* of figs. 119, and that we are then looking at the part which has been cut away, or in the direction of the dart *c'*; and we would then have a view like that shown in fig. 121, which is called a *transverse* or *cross-section*; or that it is cut on the line *e' f'* of fig. 119 and that we are looking at the front part which has been cut away, or in the direction of the dart *e'*. We will then have a view like fig. 123, or another *cross-section*. In a section of this kind the direction in which we are looking often makes considerable difference. Thus, in the section taken on the line *c' d'* of fig. 119 if we are looking backward we see the wedge *w* and the bit *i*, whereas if the view was made looking forward the bit and wedge would not be seen. It is, therefore, often important to indicate from which direction the section is drawn. It would also be possible and is often desirable to make one or more horizontal sections. That is, we may imagine that the object is sawn apart on a horizontal plane coinciding with the line *k l*, fig. 119, and that we are looking down on the lower portion thus sawn off. Such a view would be a *sectional plan*, but is not shown in the engraving. In fig. 124 the plane is supposed to be turned upside down, and we are looking at the bottom of it, and we have an *inverted plan*.



As explained in relation to the different views of the apple, illustrated by figs. 112–116, if it is desirable to show the internal

* "Catechism of the Locomotive. Revised and enlarged."

parts of an object on an external view, it may be done by dotted lines. The fact that the lines are dotted indicates that the parts represented are below the surface and hidden from view. In figs. 118, 119 and 120 part of the bit *i*, wedge *w* and handle *H* of the plane are represented by dotted lines.

The arrangement of the different views on the paper is a matter of some importance, although it is thought that some writers and draftsmen have exaggerated it very much. If we draw a side view of an object, as fig. 119, the most convenient position to put the plan is immediately above or below it, because by placing the T-square and triangle on the board we can project nearly all the horizontal dimensions of the side view to the plan without laying them off with a scale. Much time is saved in this way. Thus, by placing the base of the triangle against the blade of the T-square and bringing the perpendicular side to coincide with the front *m r* of the plane in the position indicated by the dotted line *m n*, we can draw the front end *x n*, shown on the plan, without measuring. The same thing can be done at the back end *o u* and *A p*, or the horizontal position of any line or point can be transferred from fig. 119 to the plan above it by the triangle. In the same way the horizontal positions of lines or points may be transferred from fig. 119 to the longitudinal section, fig. 122, or to the inverted plan, fig. 124. In a similar manner the vertical positions of lines and points may be transferred from the side view, fig. 119, to the end views, figs. 118 and 120, by the T-square. Thus, by placing its blade so as to coincide with the top *m o*, we can draw the top *B q*, fig. 118, or *t C*, fig. 120. In the same way other lines and points may be transferred from the one view to the other as indicated by the horizontal dotted lines. A little experience will soon teach a learner the most convenient position in which to place the different views of an object in a drawing of it. It is often determined by some special circumstance, such as the size of the paper, and is usually not a matter of very great importance.

Fig. 125

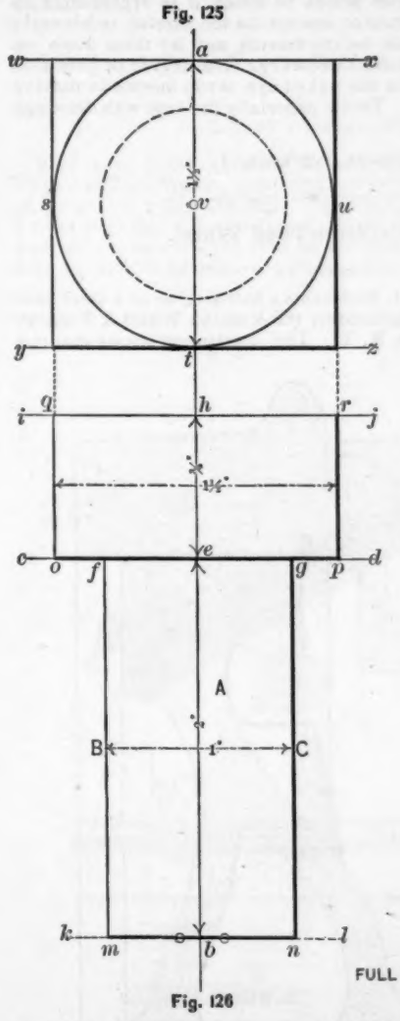


Fig. 126

Fig. 127

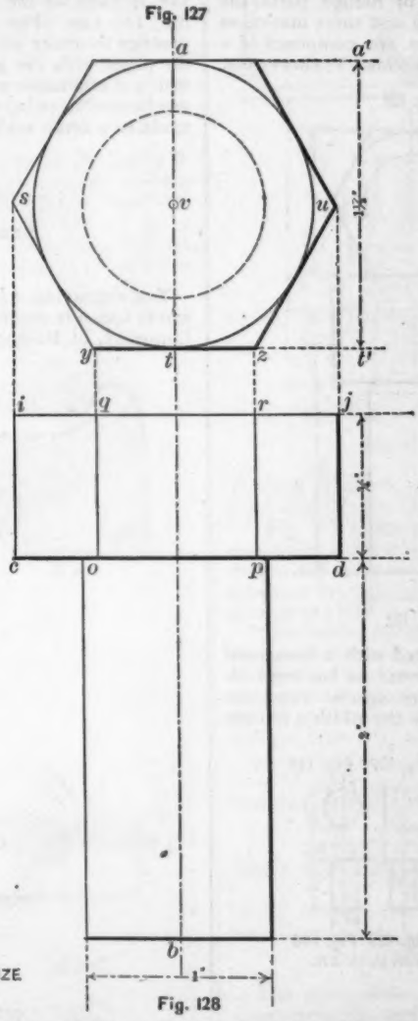


Fig. 128

FULL SIZE

CHAPTER V.

ELEMENTARY PRACTICE.

As a first example of mechanical drawing, we will take an ordinary bolt which has not been turned. It will be supposed that it is 1 in. in diameter "in the rough," as it is called, that is, as it is forged by the blacksmith; that it is 3 in. long, measured below the head, which is square, and is ⅝ in. thick, lengthwise to the bolt, and 1½ in. wide between the flat sides. In making a drawing of any symmetrical or nearly symmetrical object, it is always best to begin by drawing a center line and then lay off all its parts from this line. By this method any inaccuracies which are laid down in the drawing are confined to one measurement, whereas if a number of dimensions are laid down successively from each other, the errors are liable to be added together and they thus amount to a considerable and objectionable aggregate. By working from a center-line there is always a true starting-point for each dimension laid down.

Therefore, a vertical center line *a b*, figs. 125 and 126, should be drawn with a pencil and the aid of a triangle and T-square. At any convenient point on this line draw with the pencil and T-square an indefinite line, *c d*, fig. 126, at right angles to *a b*. If the bolt is to be drawn full size set a pair of dividers from a rule or scale so as to take accurately one-half the diameter of the bolt = ½ in. between its points. Then, from the intersection *e* of *a b* with *c d*, set off on *c d* with the dividers the distances *e f* and *e g* each equal to half the diameter of the bolt. In the same way with the dividers set off from *e* a distance *e k* = ⅝ in. or the thickness of the head, and *e b* = 2 in. the length of the bolt. Then, through the points *k* and *b* draw with a pencil the indefinite lines *i j* and *k l* and through the points *f* and *g* the perpendicular lines *f m* and *g n*. From *e* lay off *e o* and *e p*, each equal to half the width of the head of the bolt and draw the perpendicular lines *q o* and *r p* through the points *o* and *p*. This will complete the side view of the bolt. It should be mentioned that the dimensions may be set off on the paper directly from the scale, and it is often most convenient to do so, but more accuracy is possible if dividers are used, especially for dimensions which are not too great to be conveniently taken between the points.

To draw a plan or top view of the bolt, to show the form of the head, take one-half of its width with a pair of compasses and from any convenient point, as *v* on the center line *a b*, as a center and with this dimension as a radius draw a circle *a s t u*, fig. 125. Then, with the T-square, draw horizontal lines *w x* and *y z* tangent to this circle, and with a triangle from *w x* draw the perpendiculars *s* and *u* to *y z*. This, then, completes the plan, showing the shape and size of the head of the bolt. In order to show the form of its body or shank *A*, a dotted circle should be drawn from the center *v* with a radius equal to half the diameter.

Having made the drawing in pencil, it should then be inked in with a pen. In drawing with a pencil many of the lines, as *i j*, *c d* and *k l*, must be of indefinite length until the drawing is completed and such lines as *q o*, *f m*, *r p* and *g n* are laid down, as these latter define by their intersections with *i j*, *c d* and *k l* the length which the latter should be. In inking in a drawing care should be taken to ink only the essential parts of the lines, or those portions which represent the object to be delineated. The ink lines should end accurately at the points of intersection with each other, and where they should terminate. Some practice will be needed to acquire the art of doing this neatly.

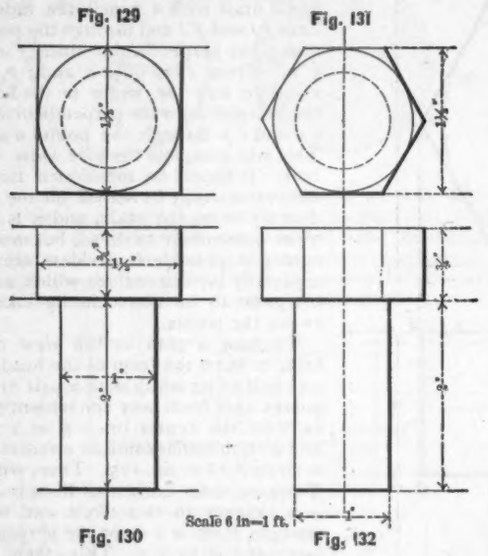
As a drawing of this kind is generally intended as a guide to a workman in making such bolts, it is important that he can learn the dimensions of it at a glance. With this in view, it is customary to mark all essential dimensions on the drawing. To indicate clearly to which parts the dimensions refer dotted lines are drawn. The dotted lines show the direction in which the measurement is made, and its limitations are indicated by marks resembling arrow points. Thus, in fig 126, to show the diameter of the bolt a dotted line, *B C*, is drawn across the body or shank, and arrow points are placed at *B* and *C*, where the dotted line meets the lines *f m* and *g n*. The diameter—in this case 1 in.—is then marked on this *dimension line*, as it is called, which shows that the measurement is to be made cross-

wise or diametrically, and the arrow points show that it is made from the lines *f m* and *g n*. If the figures represent feet a single mark is made after the figures, and if they represent inches, two marks are made. Thus, two feet and six inches is usually written on drawings thus, 2′ 6″.

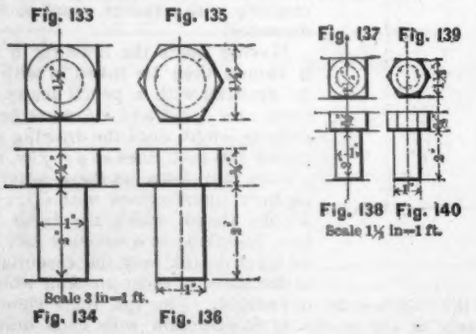
The length of an object like that represented in the drawing is often marked on the center line, as *a b*. The length of the shank, from *e* to *b*, in this case 2″, is marked as shown and also the thickness of the head from *h* to *e* = ¾″. The width of the head = 1½″ may be marked on the side view, as shown in fig. 126, or it may be indicated on the plan, as in fig. 125 from *a* to *t*. In some instances dimension lines are carried out to one side of the drawing, as in figs. 127 and 128, and the dimensions and arrow points are placed as shown in these figures.

After the drawing is completed and the lines and figures are all inked in, the superfluous pencil lines are rubbed out. In figs. 125 and 126 the pencil marks are indicated by fine lines, but in figs. 127 and 128 they are supposed to be rubbed out.

It is often an advantage to have center lines from which measurements have been made represented on drawings, and therefore they are often inked in, as *a b* in figs. 127 and 128. To distinguish center lines from those which indicate dimensions or others which represent internal or hidden parts, the first may be represented by a series of long and short marks, as *a b* in figs. 127 and 128. Dimension lines are composed of a series of long dots and hidden parts are indicated by short dots.



In figs. 127 and 128 a bolt is represented with a hexagonal head. The bolt is drawn in the same manner as has been described, excepting the head, for which some special directions are needed. To draw the head, take half the width *a t* of the



head = ¾″ in the compasses and from *v* as a center describe a circle with the pencil. Then, by the method explained in Problem 29 in Chapter III., circumscribe a hexagon about this circle. Then having drawn the lines *i j*, fig. 128, place a triangle on the blade of the T-square so as to draw a vertical line and slide it along so that it will coincide with the corner of the head at *s*, fig. 127. The line *i c*, which represents that corner in fig. 128 may then be drawn along the edge of the triangle. In the same way by bringing the triangle so as to coincide with the corners *y*, *z* and *u* the lines *q o*, *r p* and *j d*, which represent these corners in fig. 128, may be drawn.

If instead of being drawn full size the bolts were to be represented half size, or to a scale of 6 in. = 1 ft., then in making the drawing the measurements must be taken from the scale, which is marked ½—that is, ½ in. on the scale represents an inch. The drawings, figs. 129–132, can thus be made in exactly the same way as figs. 125–128 were made, the only difference being that the measurements are taken from the ½ scale instead of a full-sized rule. If the drawings are to be ¼ size, or made to a scale of 3 in. = 1 ft., as in figs. 133–136, then the measurements are taken from the scale marked ¼ or 3 in. If they are to be ⅛ size, or made to a scale of 1½ in. = 1 ft., as in figs. 137–140, then the measurement must be taken from the scale marked ⅛ or 1½.

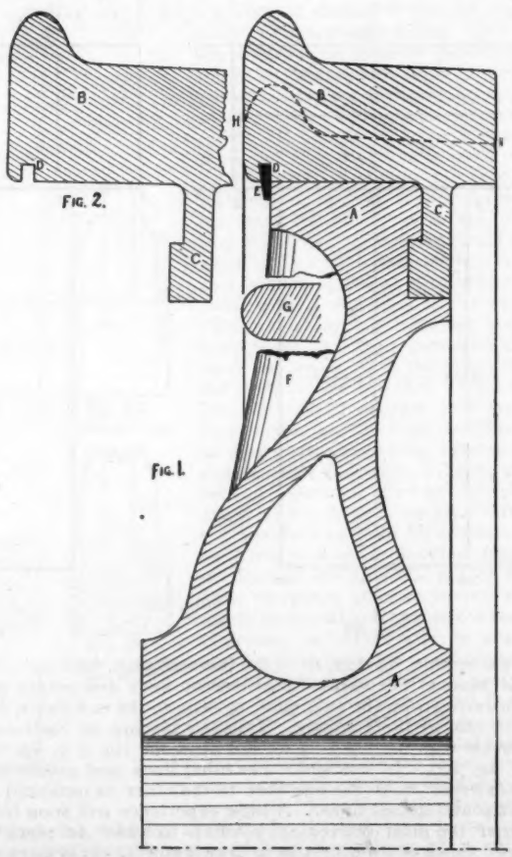
It should be remarked here that we may speak of a scale as either half size, as ½ in. = 1 in., or as 6 in. = 1 ft. In the same way a ¼ scale may be ¼ in. = 1 in. or 3 in. = 1 ft., and ⅛ may be ⅛ in. = 1 in., or 1½ in. = 1 ft. The triangular scales illustrated by fig. 7, which are intended for mechanical draftsmen, usually have scales of 3 in. = 1 ft. and of ¼ in. = 1 ft. It may be assumed of the latter that ¼ in. = 1 in. and drawings intended to be quarter size may be made either from the scale of 3 in. = 1 ft. or ¼ in. = 1 ft. The same remarks will apply to those of 1½ in. = 1 ft and ⅛ in = 1 ft. and to others on the triangular scale.

The student is advised to draw the bolts shown by figs. 125–128 to each of the four scales to which it is represented in figs. 125–140. The student cannot be too careful in his early practice to make all his measurements and lay them down on the paper with the greatest accuracy. No degree of precision which is attainable with the naked eye is too minute in making mechanical drawings. This is especially the case with drawings made to a small scale.

(TO BE CONTINUED.)

Snow's Steel-Tired Wheel.

THE engraving, fig. 1, represents a half-section of a steel tired wheel which is manufactured by the Ramapo Wheel & Foundry Company, of Ramapo, N. Y. The illustration shows that this



SNOW'S BOLTLESS STEEL-TIRED WHEEL.

wheel has the great merit of simplicity of construction. The tire is mounted on a cast-iron center of what is known as the "Washburn" pattern, which is made of the same material used

in making chilled wheels. These centers are also made with spokes, especially for locomotive trucks. Inside of the rim the Washburn form of wheel has a single plate, which divides into two as it approaches the hub, as shown in the engraving.

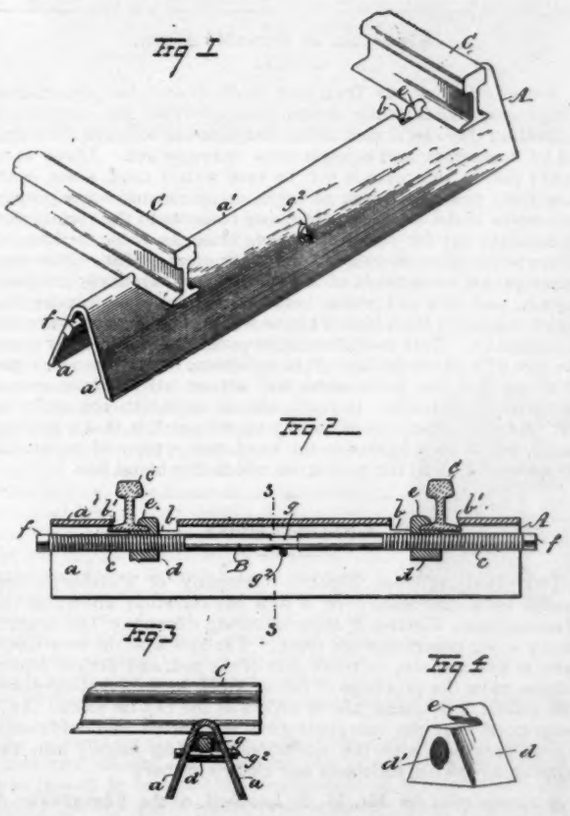
The tire is attached to the wheel by an internal flange *C*, which fits into an annular groove turned in the face of the wheel center. The tire is shrunk in the center, and is secured in its place by a ring *E* which is cut open and sprung into a groove *D* turned in the inner surface of the tire. The form of this groove when it is first turned is shown at *D*, in fig. 2. After the tire is shrunk on its center and the ring is sprung into the groove, the outside lip is hammered down, by special machinery designed for that purpose, so as to fit the ring perfectly, as shown in fig. 1. When this is done the ring, owing to its tapered form, is securely held in its place, and if the tire should break the flange *C* would hold it so long as the tire could not move outward on the wheel, which is prevented by the ring *E*. These wheels are made of three sizes—33 in., 36 in. and 42 in. in diameter—and, if simplicity of construction is an advantage, they have that merit.

The dotted lines in the section of the tire in fig. 1 show the distribution of the metal when the tire is turned down to its lowest safe limit.

Recent Patents.

TAYLOR'S METAL TIE.

FIGS. 1, 2, 3 and 4 show a metal tie invented by James P. Taylor of Fort Worth, Tex., and recently patented, the number of the patent being 428,869. Fig. 1 is a perspective view; fig. 2 a section; fig. 3 a transverse section on the line 3 3, fig. 2, and fig. 4 is an enlarged view of the clamp for holding the rail. The tie, as will be seen, is a metal plate bent into or rolled in



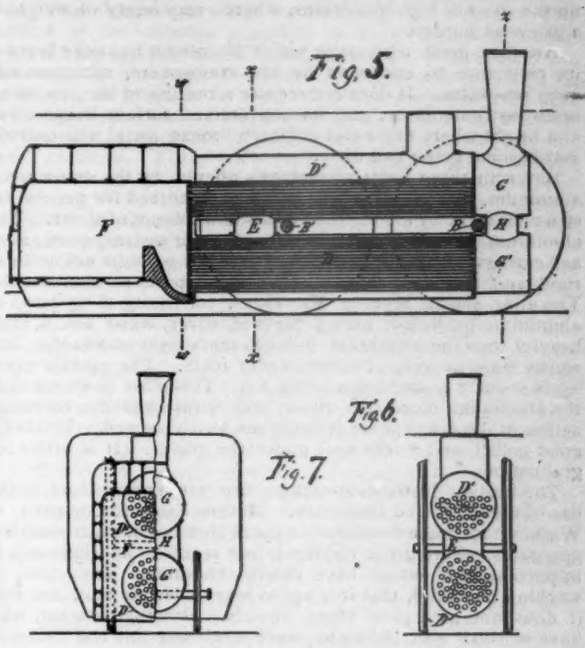
TAYLOR'S METAL TIE.

the form shown, with slots *b b* made at the apex, at the point where the rail should come. At the outer side on these slots, lips or flanges *b' b'* are formed in such a way as to hook over the base or flange of the rail when it is placed on the tie. The rails are held in place by the clamps *d d*, and through them passes an iron rod, *B*, having right and left hand screws cut upon the ends, as shown. The clamps are brought into and held in place by turning this rod with a suitable wrench placed upon the squared end *f*. A transverse bolt, *g*, is run through the tie, chiefly to hold up the rod *B* at the center and to keep it in place.

A CURIOUS LOCOMOTIVE BOILER.

Figs. 5, 6 and 7 show what may be considered one of the curiosities of the Patent Office. They represent the construction of a boiler, which is covered by patent No. 429,003, issued to Ala Berthy, of Buda-Pesth, Hungary, and can perhaps best be described in the inventor's own words, as follows:

"This invention relates to a construction of locomotive-boiler, more particularly for use with express-trains, by means



BERTHY'S LOCOMOTIVE BOILER.

of which greater speed can be obtained than was heretofore possible without reducing the stability.

"Fig. 5 is a longitudinal vertical sectional view of a locomotive-boiler embodying my improvements. Fig. 6 is a cross-section of the same on line *x x* of fig. 5. Fig. 7 is a cross-section taken on the right-hand side on the line *z z* and on the left-hand side on the line *w w* of fig. 5.

"The boiler consists of two cylindrical shells *D D'*, of which the one is situated above and the other below the driving-axles, and these shells are connected by a branch, *E*, situated behind the rear driving-axle. The fire-box *F* is common to both boiler-shells, and the smoke-boxes *G G'* of both are connected by a vertical branch pipe, *H*, in front of the front driving-axle. This connecting branch is fixed by screw-bolts, and can be removed, so as to enable the boiler to be removed from the framing when required, and also to facilitate the removal of the axles."

The Use of Aluminum in the Construction of Instruments of Precision.

(Note read before the American Institute of Mining Engineers at the Washington meeting, by William P. Blake.)

THE adaptation of aluminum to the construction of portable instruments of precision, where lightness is important, is well illustrated by the double reflecting and repeating circle, the invention of Captain Charles Heivey Townshend, of New Haven.

One of these instruments, now exhibited to the members, has just been completed by Stackpole & Brothers, of New York, and is made of aluminum, with the exception of a few minor pieces and a portion of the handle. This instrument is intended for use in a boat, and to be held in one hand like a sextant; and as it is a complete circle, lightness of the material becomes more important.

The whole instrument, as shown, exclusive of the eye-pieces and the handle, weighs only one pound, or about one-third of the weight of a sextant of the usual construction. The circle, about 9 in. in diameter, was cast in one piece from metal furnished by the Pittsburgh Company.

The mere inspection of this circle, and of the limbs of the in-

strument, is sufficient to show that the metal works well under the file, in the lathe, and under the graduating tool. The castings are homogeneous, free from blow-holes, and dress up clean and sharp. Every part, also, appears to have the requisite rigidity under the touch, although the extreme lightness raises a doubt of it in the mind.

There is also before the Institute another example of the use of aluminum in the construction of instruments by Fauth & Company, of Washington.

The great advantage of lightness in such instruments will be appreciated by those who have had to carry instruments of the usual construction through the devious passages of mines and up the sides of high mountains, where every ounce of weight is a grievous burden.

Another great advantage which aluminum has over brass is its resistance to corrosion by the atmosphere, moisture and even sea-water. It does not require a coating of lacquer, as all brass instruments do, and its unprotected surface keeps clean and bright where brass and ordinary bronze metal will corrode and become green and dirty.

But with these great advantages offered by the commercial aluminum, it is probable that it can be improved for general instrument work by the addition of a small amount of silver. The aluminum, it must be said, is rather soft for wearing parts, such as bearings and rubbing-surfaces, and it is perhaps not quite as rigid and stiff as it should be for some parts of instruments. The alloy shown here by Mr. Hunt, consisting of 95 parts of aluminum by weight and 5 parts of silver, while but a little heavier than the aluminum, is much more rigid and harder, and works quite as well, or better, under tools. The specific gravity is about 3.2, aluminum being 2.6. This alloy is whiter than the aluminum, more like silver, and withstands the corrosive action of the atmosphere and sulphur nearly as well. It takes a good polish, and works well under the graver. It is better for graduation.

The leading instrument-makers are yet very cautious in the use of the unalloyed aluminum. Messrs. Fauth & Company, of Washington, make considerable use of aluminum in astronomical apparatus, where great rigidity is not required and lightness is important, and which have careful handling. They find, in working the metal, that it is apt to tear under the tool, and that it does not give good clean threads. Others, however, who have worked with the metal, have overcome this last difficulty by a little care in the use of the tap and die.

The Keuffel & Esser Company, of New York, have been experimenting with aluminum in their shops, and have made some sextants of it which have proved to be satisfactory as far as the limited experience in the use of them has shown. They have also a mining transit of aluminum in construction, some portions of the instrument being, however, made of a harder and heavier metal.

While the unalloyed aluminum is no doubt soft and somewhat "spongy" in working, the evidence presented in the finished instrument exhibited at this meeting is sufficient to show that the metal and its alloys have great merit as materials for the construction of instruments of precision.

The Accident to the "City of Paris."

THE investigation into the accident to the steamer *City of Paris*, ordered by the British Board of Trade, resulted in a report and verdict, the essential part of which is as follows:

"In the judgment of the Commission, full provision was made to insure the safety of the *City of Paris* as an ocean-going steamer, and safety was in no way sacrificed to speed. We consider cast steel a proper and suitable material to be employed generally in the construction of the various parts of the engines hitherto usually made of cast iron. The propeller shafts, both inboard and outboard, appear to have been sufficiently supported. Those of the port engine showed little or no signs of wearing. The after bracket is properly constructed, and is of sufficient strength for the shafting and propeller it has to support. The bushes in the stern tubes and after brackets and the linings of the casings are of suitable material and are properly constructed. The cylinders, pistons, rods and other parts of the machinery are also of suitable material and well constructed.

"The bulkheads are sufficiently strong to stand any pressure, assuming that any two compartments are flooded at the same time, in any state of the weather. The longitudinal bulkhead between the engine rooms is of sufficient strength and is carried sufficiently high. The cracks in the cast-steel columns caused by contraction were repaired with steel plates in a very efficient and workmanlike manner.

"The primary cause of the casualty was the extraordinary wearing down of the brass in the bracket supporting the extreme end of the propeller shaft, whereby the end dropped about seven inches, producing a bending effect on the shaft at its forward support with each revolution. This probably produced finally a total fracture. The cause of the water finding its way into the compartments was that a large portion of the low-pressure cylinder fell against the condenser, tearing it away and thereby opening a large communication with the sea, through which the water rushed in such volume that before any of the inlets could be closed they became covered with water and out of reach. The water passed into the dynamo room and port engine room through the bulkheads, which were broken by the ruptured machinery, and into the two compartments by the injury to the valve box in the engine room.

"After the practically unanimous testimony of eminent authorities of the Board of Trade, Lloyds and other experts, upon the strength, completeness, and efficiency in all respects of the ship for the service for which she was especially designed and built, the Court does not consider itself in a position to offer suggestions thereon. During the course of the inquiry we had evidence that, even if some of the forward compartments of the ship had been filled with water in addition to those that were filled, she would still have had a fair amount of free-board, and would have been able to float, her mean draught on reaching Queenstown being only 8 in. more than when she left New York.

"We are of opinion, having regard for the trying ordeal through which she passed, that the vessel proved herself to be one of the finest and safest in the mercantile marine."

Without intending to make unfavorable comments on the ship, the Court suggests, as precautions which should be considered in future, the use of a governor to control marine engines; the improvement and strengthening of the supports for the outboard bearings of long propeller shafts, and the isolating of compartments as much as possible in all steamers.

Manufactures.

Aluminum in Portable Form.

A GREAT deal has been said lately about the properties of aluminum, and it really seems probable that the methods of extracting this metal may be so cheapened as to make it an article of commerce and bring it into ordinary use. There is no doubt that in this case it will be very widely used, since it undoubtedly possesses great strength, lightness and other properties which make it superior in many respects to the metals now in ordinary use for many purposes, while its value in forming alloys with other metals will be very great. But, while very many people have heard of aluminum, comparatively few have seen it, and this will make very interesting the business card which has lately been issued by the well-known firm of Valentine & Company. This card is made of pure aluminum and is about the size of a silver dollar. It is handsome in appearance, equal to silver, and the point which will attract attention at once is its extreme lightness. It really almost seems to contradict all our received ideas, for it hardly seems possible that a piece of metal, which feels lighter in the hand than a piece of paper, can be possessed of all the properties which this metal has.

Electrical Notes.

THE Westinghouse Electric Company of Pittsburgh has passed into the control of a new organization known as the Westinghouse Electric & Manufacturing Company, the organization being practically the same. The stock of the new Company is $10,000,000, or twice that of the old, and the old stockholders have the privilege of taking stock in the new Company. The assets, it is stated, are in excess of the capital stock. It is understood that the reorganization is effected and additional capital provided with the intention of going largely into the building of electric railroads and electric motors.

A PAPER read by Mr. M. B. Leonard, of the Chesapeake & Ohio Railroad, at the recent convention of the Railroad Telegraph Superintendents, refers to the use of electric lighting in railroad service. The employment of electric lights in freight and passenger stations is becoming general, but does not call for any special mention, as the methods employed do not differ from those in use in ordinary manufacturing establishments, public buildings and similar places.

The electric light has been tried for locomotive headlights, and it is now believed that the difficulty at first experienced, the constant vibration of the locomotive affecting the feeding mechanism of the lamp, has been overcome, and a light has

been obtained which can be relied upon. It may be mentioned, however, that authorities are not agreed as to whether it is desirable to have too brilliant a headlight.

The electric lighting of passenger trains has not so far made much headway in this country, although used to a considerable extent abroad. The storage battery system, which was tried by the Boston & Albany Railroad, has been abandoned by that Company, but the Pennsylvania Company still continues to light its parlor cars from storage batteries, and a similar system has been adopted by the Intercolonial Railroad of Canada on the through trains between Halifax and Quebec. The Pullman Company is using a combination of dynamo and storage battery, and the Chicago, Milwaukee & St. Paul Railroad Company is using on two of its trains a dynamo carried in a separate car.

The Southern Pacific Company is now using a large number of electric switch signal lights in its yard at Oakland, Cal., with much success. The electricity is supplied from the plant used for lighting the station and pier at Oakland.

An Improved Universal Trimmer.

THE accompanying illustration shows a universal trimmer for the use of pattern-makers, coach-builders and other wood-

IMPROVED UNIVERSAL TRIMMER.

workers, which is manufactured by the Grand Rapids Machinery Company at Grand Rapids, Mich. In the cut *A* shows a block of wood, the size in this case being 2 × 10 in.; the knife is propelled through the wood by grasping the handle *E* and moving it toward the opposite end of the machine. This handle is adjustable to any one of five notches in the fulcrum *D*, which makes the operation of the machine more convenient. The fulcrum *D* is provided with a roller which works in the slot *F*, a device by which the power can be applied to the best advantage. The circular ways in which the carriage travels give a drawing stroke which can be seen at *C*, being the space between the bed of the machine and the bottom of the lower way. For instance, in trimming the end of a 1 × 12-in. board, 3 in. of the knife edge are used, thus distributing the wear on the knife instead of bringing it upon one point. The machine is provided with link stops *H*, which can be set when several pieces of one size are to be trimmed. The gauges *G* are always held in the same relation to the knife, no matter at what angle they may be set. They are hung in the bearings *B B* and can therefore slip away from the knife.

The advantages claimed over other forms of machine are the circular way, making the cut easier; the adjustable handle which can be placed to best suit the convenience of the operator; the weight; the link stops where several pieces are required; the pivoted gauges, positive in their action and needing no spring to keep them off the knives, and also forming a brace for the top frame; and the fact that the knives need no shields, as they do not project outside of the frame.

These machines are adapted to the use of almost all woodworkers and will be especially convenient for pattern makers. A number of different sizes are manufactured. The illustration shows one of No. 13, which weighs 150 lbs. and has a 12-in. stroke. We are informed that a number of these machines are now in use and have met with general approval wherever they have been tried.

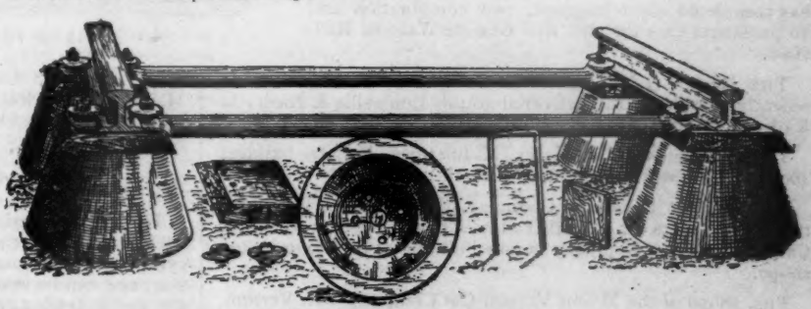
A Wrought-Iron Chimney.

THE description of a wrought-iron chimney of novel design, which has recently been built at Creusot, France, is of interest. The chimney stands on a masonry foundation, extending 3 ft. 3 in. above the ground, and is an iron tube 279 ft. high, 23 ft. in diameter at the base and 7 ft. 6 in. at the top. The weight of iron is 80 tons. The shaft was built in successive rings, each 4 ft. 1 in. in height, the thickness varying from $\frac{9}{16}$ in. at the bottom to $\frac{1}{2}$ in. at the top. The nine lower rings were formed of eight plates each, the upper ones of four plates each. The base was encircled by a massive angle iron bolted to the foundation. The eight lower rings were lined with fire-brick. The erection of the chimney occupied 70 days, including taking down the flying scaffold. The latter was of a somewhat novel character. It consisted of a central wrought-iron tube 7 in. in diameter, and provided at the bottom with four wooden cross-bars or arms, so clamped that their length could be adjusted to suit the varying diameter of the chimney and carrying the internal platform. These arms rested on angle brackets refitted to the interior of the plates. The upper part of the central tube carried four cross-arms, or jibs, each consisting of a pair of timbers stiffened by raking struts from the central tube. From their outer ends was slung the exterior circular platform.

The latter consisted of a pair of angle-iron rings, to the outer part of which was riveted a plate-iron fence, while the inner was provided with T-iron stanchions. Radial bearing timbers, resting on these rings, and adjustable endwise to suit the varying diameter of the chimney, carried the platform, an annular space being left just sufficient for hoisting the plates. The latter operation was effected by a rope passing over an adjustable pulley fixed to each jib in turn, and carried down a central tube to a snatch block fixed at the bottom of the chimney. As each successive ring was riveted up, two pairs of bars were laid across, by which the scaffold was slung by four jack-screws furnished with ratchet collars, and thus raised high enough to take a bearing on the next set of angle braces. The complete scaffold weighed about four tons, and the heaviest plate about 900 lbs. The chimney cost about $8,000, not including the masonry foundation.

Blaine's Vitrified Clay Ties.

THE accompanying illustration shows the vitrified clay tie devised by Mr. George E. Blaine, of Dayton, O. The cut shows the arrangement very clearly, the base or foundation consisting of a conical support of vitrified clay, as the inventor calls it, while the rails are held in place by chairs and rods, the flat chair resting on the clay base, and holding the rails by bolts and clamps.



BLAINE'S VITRIFIED CLAY TIE.

A number of these ties were put in on a side-track in the New York, Pennsylvania & Ohio yard in Dayton, O., some ten months ago. The track is constantly used for heavy switching and we are informed that at the present time "the ties appear to be in as good condition as when put in, and to hold the rail in line and surface."

Marine Engineering.

IT is understood that the property of the Delaware River Shipbuilding Company, at Chester, Pa., together with the Morgan Iron Works in New York, will pass into the hands of a new concern, to be incorporated under the name of the Roach Shipbuilding & Engineering Company. The stock of this company will be largely held in London, but a portion of it will be placed

in this country. The works will be managed by an American board, with John B. Roach, George E. Reed and Henry Steers at its head. The new concern will have a capital of $1,500,000 preferred stock; $1,500,000 common stock, and $3,000,000 debenture bonds.

Manufacturing Notes.

THE contract for furnishing eight large lathes for the Government gun factory at the Washington Navy Yard has been awarded to William Sellers & Company, Philadelphia, the contract price being $416,460. With these lathes guns of the largest size can be finished.

AT the shops of William Tod & Company, Youngstown, Pa., engines are under construction for the Latrobe Steel Works, the Anniston Rolling Mill and the Pennsylvania Steel Company. A pair of large blooming mill engines are being built for the Pennsylvania Rolled Steel Wheel Company at Norristown.

THE Detroit Wheel & Foundry Company, Detroit, Mich., has a contract for iron work for the new lighthouse station at the mouth of the Mississippi.

THE Nashua Iron & Steel Company, Nashua, N. H., is making the shafting for two Government cruisers now building in Baltimore.

THE St. Louis Iron & Machine Works are building a new erecting shop 232 × 80 ft. This building will be provided with steam cranes traveling its entire length, and will have a wide gallery on either side, in which a number of machine tools will be placed.

THE new plant of the Pennsylvania Steel Company, at Sparrow's Point, near Baltimore, has now four blast furnaces in operation and work is progressing on the Bessemer steel plant and the machine shops. The steel works will have four 18-ton converters, a blooming mill and a rail mill. Work will soon be begun also on an open-hearth steel plant. Preparations are being made for constructing a large shipbuilding plant in connection with these works.

Cars.

THE works of the United States Rolling Stock Company, at Anniston, Ala., are building 200 flat cars for the Montgomery, Tuscaloosa & Memphis Railroad.

THE St. Charles Car Company, St. Charles, Mo., has completed eight baggage, two combination and 16 passenger cars for the Rio Grande Western Railroad.

THE Harlan & Hollingsworth Company, Wilmington, Del., recently completed and delivered to the Louisville & Nashville Railroad 11 first-class passenger coaches.

THE Middletown Car Works, Middletown, Pa., are building 400 iron cars, which are to go to Brazil.

THE Scarritt Furniture Company, St. Louis, is furnishing the Scarritt seats for a number of new passenger cars which the Chicago & Alton Company is now building at its Bloomington shops.

THE shops of the Mount Vernon Car Company, Mt. Vernon, Ill., are nearly completed and were to start up about August 1 on an order for 200 hopper-bottom gondolas for the Louisville & Nashville Railroad.

THE Erie Car Works, Erie, Pa., have large orders for cars for the Pennsylvania Railroad; the Union Pacific; the Missouri Pacific; the Baltimore & Ohio; the New York Central; the Columbus, Hocking Valley & Toledo, and the Cleveland, Cincinnati, Chicago & St. Louis Railroad.

THE South Baltimore Car Works have a contract for a large number of box-cars and gondolas for the Baltimore & Ohio Railroad.

THE Iron Car Company, which recently suspended payment, is to be reorganized, arrangements to that effect having been made at a meeting of the creditors and stockholders. The creditors have granted time and are to be paid in full, and it is understood that a large amount of new capital is to be put in the concern.

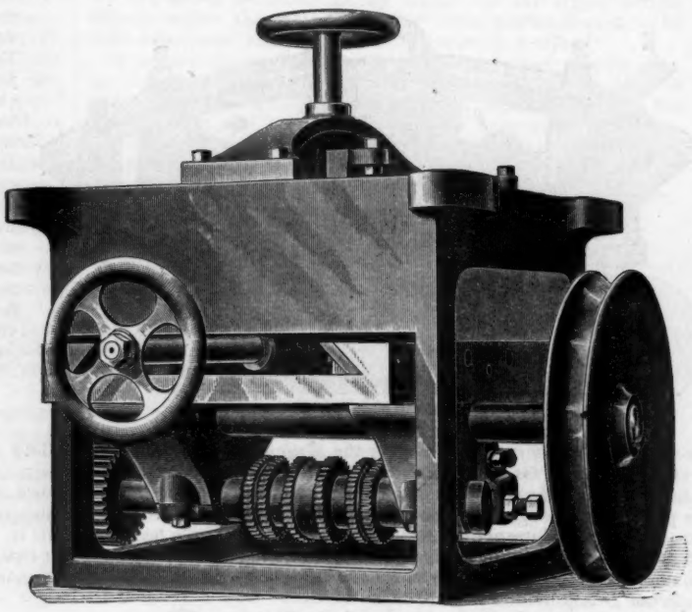
Locomotives.

THE Rogers Locomotive Works, Paterson, N. J., recently completed six heavy switching engines for the Lake Shore & Michigan Southern Railroad, and two heavy freight engines for the Birmingham Mineral Railroad in Alabama.

THE Baldwin Locomotive Works, Philadelphia, are building 25 consolidation freight engines, with Wootten fire-boxes, for the New York, Lake Erie & Western Railroad, and 25 consolidation engines, with 20 × 24-in. cylinders, for the Rio Grande Western Railroad. These works have received an order for 30 Forney engines for the Manhattan Elevated Railroad.

THE Brooks Locomotive Works, Dunkirk, N. Y., recently completed 20 ten-wheel engines for the Lake Shore & Michigan Southern Railroad. They are building 25 engines, with 18 × 24-in. cylinders, for the Illinois Central.

THE New York Locomotive Works, Rome, N. Y., are building 8 eight-wheel locomotives, with 17 × 24-in. cylinders, for the Charleston, Sumner & Northern Railroad. They are also building six passenger engines, with 18 × 24-in. cylinders, and four with 17 × 24-in. cylinders, for the Rio Grande Western Railroad.



VALVE PORT MILLING MACHINE.

THE Portland Company, Portland, Me., is building for the Maine Central Railroad four mogul passenger engines, with 19 × 26 in. cylinders, and driving wheels 65 in. in diameter.

The Davis Valve Port Milling Machine.

THE accompanying illustration shows a very convenient and useful machine for milling out ports in the valve faces of steam cylinders. It is much lighter than a cylinder of any ordinary size, and can be readily placed upon one while in position, using the stud holes for attachment. It is claimed that by it work can be duplicated exactly and in very short time.

The machine, as shown, consists of a frame that is of itself a template resting on the seat that the studs are placed in and that supports the steam-chest; this frame carries another frame, which has two distinct movements, carrying milling cutters that are arranged on a mandrel with space washers, so that the bridges and ports can be all cut to dimensions at one operation. The inner frame is fed down into the cut by the hand-wheel and screw shown on top, and is fed the length of the ports by the hand-wheel. The machine is operated by a rope belt similar to that used for driving drills.

This machine is made by the well-known firm of Pedrick & Ayer, of Philadelphia.

A Triple-Expansion Pumping Engine.

THE Risdon Iron & Locomotive Works, San Francisco, have completed a triple-expansion pumping engine on the Davidson

system for the town of Jamaica, N. Y. The steam cylinders are 9 in., 14 in. and 24 in. in diameter and 24 in. stroke; the pump is 24 in. in diameter. The intended duty is 4,000,000 gallons per day, but the pump has performed 50 per cent. more without excessive piston speed. The three cylinders are arranged in tandem fashion, but the arrangement is a somewhat unusual one, the high-pressure cylinder being in the rear; then the low-pressure and the intermediate cylinders in the front. This calls for a special arrangement of the piston rods to avoid internal packing. The high-pressure piston at the rear end is connected with the piston of the low-pressure cylinder in the middle. From the pistons of the latter there are two rods passing alongside of the intermediate cylinder, in tubes provided with packing glands next to the pump at the front. These two rods are there keyed into a crosshead on the rod connecting the intermediate and pump pistons, so that the high and low-pressure pistons are on one rod and the intermediate and pump pistons on another, the two sets being connected by the double side rods.—*Industry, San Francisco.*

OBITUARY.

EDWARD FRY, who died in Brooklyn, N. Y., June 26, was formerly Engineer in the Navy. Since 1878 he had been connected with the Brooklyn Water Works, and for several years had charge of all the pumping machinery.

CHIEF ENGINEER E. S. DE LUCE, U. S. N., died at New Brighton, N. Y., June 25, aged 62 years. He was appointed Third Assistant Engineer in 1849, promoted in 1851 and 1853, and made Chief Engineer in 1861. During the War he had charge of the Machinery Department at the Boston Navy Yard and afterward at the Brooklyn Yard. He was retired in 1879, after 30 years' service.

MAJOR-GENERAL JOHN CHARLES FREMONT, who died in New York, July 13, aged 77 years, was best known publicly from his military and political career, an account of which need hardly be given here. In early life he served for two years in the Navy and from 1838 to 1848 he was an officer in the old Corps of Topographical Engineers. In that position he made the explorations of the then unknown regions of the Rocky Mountains and the Sierra Nevada, which gave him a great reputation. General Fremont may be said to have been the first man who found a practicable railroad route to the Pacific, and he made strenuous but unsuccessful efforts to build such a road on the Southern line, which he always favored as the best.

DR. CHRISTIAN HENRY FREDERICK PETERS died suddenly at Clinton, N. Y., July 19. He was born in Germany in 1813 and graduated at the University of Berlin, after which he continued his studies at Copenhagen. In 1838 he accompanied Baron von Waltherhausen to Sicily, where until 1843 he was engaged on the survey of Mount Etna. The published results of this work are said to afford the most exhaustive description that has been given of any mountain. On the completion of this survey Dr. Peters was engaged in Naples for several years in the geodetic survey of that kingdom. At the close of the revolution of 1848 he left Italy and went to Turkey, where he continued his scientific researches. In 1853, on the recommendation of Mr. George P. Marsh, he came to America. His letters from European scientists procured for him employment in the United States Coast Survey, he being stationed first at Cambridge Observatory and later at the Dudley Observatory, Albany. In 1858 he was appointed director of the Litchfield Observatory of Hamilton College at Clinton, and a few years later was made Professor of Astronomy in the College also; he retained both positions until his death. He was considered one of the most able of modern astronomers. He was at the head of the expedition which, in 1869, observed the eclipse of the sun from the station at Des Moines, Iowa. Dr. Peters discovered more asteroids than any other astronomer. He catalogued over 75,000 zodiacal stars and recovered more than twelve thousand solar spots. He was employed by the Regents of the University of New York to determine the longitude and latitude of places in the State. His first series of celestial charts, 20 in number, published in 1882, give accurate pictures of the parts of the sky they severally covered, each marking the place of from 2,500 to 3,500 telescopic stars.

GENERAL SILAS SEYMOUR, who died in New York, July 15, aged 73 years, was one of the best known civil engineers in the country, and it was his fortune during the early months of the Civil War to render the Government timely service in organizing the military railroad service. He was born in Stillwater, N. Y. His career as an engineer began in the preliminary surveys of the New York & Erie Railroad, and he had become Engineer and Superintendent of Transportation when that road was completed as far as Dunkirk. He then built the Buffalo & New York City Railroad, now part of the Erie, and on this line was the famous Portage Bridge, probably the greatest wooden bridge ever built, 800 ft. long and 234 ft. high, over the Genesee River. The firm of Seymour, Morton & Company, which Mr. Seymour organized in 1854, now began a large and increasing business in railroad construction throughout the country. He was elected State Engineer of New York in 1855, and soon after was appointed by the United States Government to report upon the feasibility of bridging the Mississippi River at Rock Island. When the War broke out he was employed by the War Department for a time in organizing the military railroad service, and afterward served on the staff of General Daniel E. Sickles. He was appointed Chief Engineer of the Washington Aqueduct in 1863, and at this time also he built a new railroad bridge across the Potomac. In 1864 he became Consulting Engineer of the Union Pacific Railroad Company, and was engaged in the construction of that great work until its completion. From 1872 to 1878 he was in Quebec as Engineer of the North Shore Railroad, and in the latter year was chosen President of the Massachusetts Central Railroad Company. In 1880 he became Consulting Engineer of the New York, West Shore & Buffalo Railroad, and in the following year was again elected State Engineer of New York. It was during this term of service that General Seymour's views on the canals and the preservation of the timber of the Adirondacks were made prominent. Since the expiration of his term as State Engineer he has done business in New York as a consulting expert, maintaining connection with various enterprises. General Seymour's writings on subjects concerning his profession have been valuable, and occasional rather than voluminous.

PERSONALS.

DANIEL BONTECOU has been appointed Chief Engineer of the Kansas City, Fort Scott & Memphis Railroad.

A. C. HIPPEY, recently on the Pennsylvania Railroad, has been appointed General Superintendent of the Norfolk & Western Railroad.

C. A. BARTLETT is Engineer in charge of the construction of the first division of the new Winona & Southwestern Railroad in Minnesota.

F. N. FINNEY, formerly of the Wisconsin Central, is now President of the Minneapolis, St. Paul and Sault Ste. Marie Railroad Company.

A. A. MCLEOD, late General Manager, has been chosen President of the Philadelphia & Reading Railroad Company, in place of AUSTIN CORBIN, who has resigned.

EDWARD DICKINSON has been appointed General Superintendent of the Trans-Ohio lines of the Baltimore & Ohio Railroad. He has been for some time past on the Union Pacific.

S. H. HARRINGTON is now Mechanical Engineer of the Cleveland, Cincinnati, Chicago & St. Louis Railroad. He recently held the same position on the New York, Lake Erie & Western.

E. A. WILLIAMS has been appointed Master Mechanic of the Minneapolis, St. Paul & Sault Ste. Marie Railroad, succeeding T. A. FRASER, who has accepted a position with the Wells & French Company, of Chicago.

M. D. WOODFORD has been elected President of the Cincinnati, Hamilton & Dayton Railroad Company. He was recently General Manager, and has served on the Erie, the Michigan Central and the Wheeling & Lake Erie.

JOHN MCLEOD has been appointed General Manager of Construction of the Richmond, Irvine & Beattyville Railroad, a line about 100 miles long in Kentucky. He has also charge of the building of the New Albany Belt Railroad.

JOHN W. CLOUD is now Western Representative of the Westinghouse Air Brake Company, with office at 974 Rookery Building, Chicago. R. A. PARKE is Eastern Representative of the same Company, with office at 160 Broadway, New York.

MAJOR J. C. PAUL, late General Manager of the Woodruff Sleeping Car Company, and Superintendent of Equipment of the Pullman Company, has been appointed Vice-President of the American Steel Car Wheel Company, with office in New York.

F. T. HATCH has been appointed Engineer of Maintenance of Way on the Pittsburgh, Cincinnati & St. Louis, succeeding GEORGE W. KITTRIDGE, who recently left that position to become Assistant Chief Engineer of the Cleveland, Cincinnati, Chicago & St. Louis Railroad.

CHARLES PAINE, late of Pittsburgh, has established an office in New York, with his two sons as partners, the firm name being Charles Paine & Company. The new firm will act as consulting engineers for railroad and other work. Mr. Paine's long experience and high reputation as an engineer make all comment unnecessary.

PROFESSOR JOHN SMOCK has been appointed State Geologist of New Jersey, to succeed Professor George H. Cook, deceased. Professor Smock has been for some time at the head of the Museum of Natural History at Albany, N. Y., but was formerly for several years employed as Assistant to Professor Cook on the New Jersey survey.

EDWARD W. KINSLEY has been reappointed a member of the Massachusetts Railroad Commission for another term. He has been on the Commission for 11 years, having been first appointed in 1878, and having served continuously since that time, with the exception of one year. Mr. Kinsley has been an active member of the board and has practical knowledge of railroad work and an acquaintance with railroad problems which have made him a very useful one.

PROFESSOR JAMES RUSSELL SOLEY has been appointed Assistant Secretary of the Navy, a new office, just created by law. He is a Massachusetts man, graduated from Harvard College in 1870 and was soon afterward appointed Assistant Professor in the Naval Academy at Annapolis. In 1873 he was made Professor; in 1878 he was sent on special duty to the Paris Exposition of that year, and in 1882 he was transferred to Washington, where he has since been in charge of the Library of the Navy Department, and of all its publications.

PROCEEDINGS OF SOCIETIES.

Master Car Builders' Association.—The office of John W. Cloud, Secretary, has been moved from Buffalo to Chicago. His address is now 974 Rookery, Chicago, Ill.

Institution of Civil Engineers of Japan.—A special meeting or convention, lasting for a week, was recently held at the Imperial College of Engineering near Tokio, Japan, to celebrate the 10th anniversary of the foundation of this Society. The programme included a business meeting, the reading of papers on different subjects, a banquet and visits to a number of public works, including the Shinbashi Railroad Works; the Fukugawa Copper Works; the Ishikawa Gima Docks; the Kanegafuchi Cotton Mills and other establishments.

A large number of members and invited guests were present at the meeting, in which much interest was taken. The Society originally included only graduates of the Imperial University, but all engineers engaged in civil, mechanical, electrical work, naval construction and architecture are now admitted. There are over 1,000 members in the Society.

The officers are: President, Yamao Yozo; Vice-President, Watanabe Hiromoto; Secretaries, M. Shimudza and M. Matsuo. The President was recently Minister of Public Works and the Vice-President is President of the Imperial University.

American Society of Civil Engineers.—The Annual Convention began at the Mountain House, Cresson, Pa., June 26. Mr. William Metcalf was elected Chairman, and the customary routine business was gone through with. At the first session papers were read on the Oakley Arch, by Mr. J. Foster Crowell; on Cross Sections in Deep Rock Cuts, by F. W. Watkins; on Stresses in Elastic Systems, by William Kane, and on the Temperature of Water, by Desmond Fitzgerald. All of these papers were discussed.

At the session of the second day papers were read and discussed on Comparative Tests of an Electric Motor and the Steam Locomotive on the Manhattan Elevated Road, by Lincoln Moss; on Irrigation in India, by H. M. Wilson; on the Cheapest Railroad in the World, by Arthur Pou, and on Permanent Effects of Strains in Metals, by Professor R. H. Thurston.

At the evening session President W. P. Shinn delivered his annual address, which was a summary of the progress of engineering during the past year. Mr. R. B. Stanton then gave a description of the great Cañon of the Colorado.

On the third day, Friday, in the morning there was an excursion to Johnstown, in which most of the members joined. A session was held in the afternoon, at which a number of papers were read and discussed. In the evening the annual banquet was held.

On the fourth day, Saturday, an excursion was made in the morning over the Bell's Gap Railroad; in the afternoon a business session was held, at which reports of progress were received from the standing committees. A communication from the Western Society of Engineers on an International Engineering Congress was presented, and the President was authorized to appoint a committee to consider the subject and meet with other committees. The usual nominating committee was appointed. In the evening the members were taken by a special train to Altoona to attend a reception given in their honor by Mr. and Mrs. Theodore N. Ely.

At the Monday morning session a number of papers were read, including one on the Litoral Movements of the New Jersey Coast, by L. M. Haupt; Electric Railroads of Nashville, by O. H. Landreth; Ventilation of Tunnels, by N. W. Eayres; the Silverton Railroad, by C. A. Gibbs; the South Park Dam, by A. N. Snyder; Break in the Champlain Canal, by Secretary Bogart. A number of other papers were read by title.

The meeting concluded in the afternoon by a visit to the great shops at Altoona, to which members were carried by special train.

International Association of Car Accountants.—The Annual Convention was held in New York, beginning June 24. The following officers were elected for the ensuing year: President, E. M. Horton, Illinois Central; Vice-President, C. H. Ewings, New York Central; Secretary, S. P. Sechrist, Cleveland, Ohio; Treasurer, M. C. Traut, Toledo & Ohio Central; Executive Committee, A. Hale, C. J. Fellows and C. P. Chesebro.

Reports were presented by the various committees; those on Cypher Code, Demurrage and Per Diem Car Service received special attention and called out long discussions.

A number of papers were presented, including Errors and their Correction, by A. Hale; Straight per Diem, by M. C. Traut; Detention of Foreign Cars, by A. D. Penfold; Decreasing Mileage of Cars, by W. G. Wattson; Economical Working of the Car Record Department, by Edmond Yardley.

It was decided to hold the next meeting at Denver, Col. Besides the business of the Convention, which lasted three days, the members were entertained by a trip to West Point and return, and an excursion to Long Branch and Ocean Grove.

American Boiler Makers' Association.—The annual meeting began in New York, July 1. It was opened by a short address from the President. At the first session reports were presented by Committees on Manholes; on Materials and Tests; on State Inspection Laws; and on Riveting and Calking, all containing matter of much interest. The Convention remained in session for three days, discussing a number of practical questions, including the subjects mentioned above, and also Raising the Standard of Work and Workmen; Boiler Insurance; Safety Valves and Horse-Power. Particular attention was paid to the subject of State Inspection Laws.

The following officers were elected for the ensuing year: President, James Lappan, Pittsburgh. Vice-Presidents, Philip Rohan, St. Louis; John Mohr, Chicago; Christopher Cunningham, Brooklyn. Secretary, A. T. Douthett, Allegheny, Pa. Treasurer, R. Hammond, Buffalo, N. Y. During the Convention the members visited the Brooklyn Navy Yard, took an excursion around the Harbor, and visited several New York establishments.

Association of Railroad Telegraph Superintendents.—The ninth annual meeting was held at Niagara Falls, June 18 and 19. The following officers were elected: President, George T. Williams, Cleveland, Ohio; Vice-President, George M. Dugan, Jackson, Tenn.; Secretary and Treasurer, P. W. Drew, Chicago.

A number of papers of much interest were read, including one on the Development of the Block System, by Robert Stewart; Special Lighting at Wrecks, by W. F. Taylor: Electric Lighting in Railroad Service, by B. Leonard; Train Dispatching, by George C. Kinsman; Correct Time, by Professor H. S. Pritchett, and the Ries System for Increasing Adhesion, by Charles Selden. These papers and a number of other subjects were discussed.

It was resolved to meet next year in Cincinnati. A number of new members were elected.

Boston Society of Civil Engineers.—At the regular meeting, June 19, Francis Blake, Frank P. Johnson, George H.

Nye, and George C. Stoddard were chosen members; Edward P. Fisk, an associate member.

The subject for the meeting was the Treatment of Sewage, and three papers were read: The Purification of Sewage by Filtration and Chemical Precipitation, by Hiram Mills of the State Board of Health; the Sewage Disposal Works at Worcester, by Charles A. Allen, City Engineer; Treatment of Sewage at Winchester, by W. F. Learned, Assistant Engineer of the Boston Water Works. The several papers were fully discussed.

Civil Engineers' Club of Cleveland.—At the regular meeting, July 8, James Morris Wright was chosen a member. The Committee on Affiliation reported that nothing was accomplished at the Conference in New York. Notice was received that the Iron & Steel Association of Great Britain will not visit Cleveland as a body. The first and second proposed amendments to the Constitution of the Association of Engineering Societies were discussed and adopted.

Mr. C. O. Arey read a paper on Methods of Wall Decoration.

After noting the objections to oil-colors and the kalsomining process, he narrated his experience with other methods. The encaustic process, as practised by the ancient Greeks, was found too expensive. The fresco practised by the early Renaissance was found satisfactory, with the exception that the work was liable to be injured or broken after completion, by the finishing carpenters. He then tried many experiments to find a method similar to this fresco which could be applied on a dry wall, this was accomplished by a chemical union of alum and lime, providing only mineral colors were used. This method allows one to apply on the wall a permanent finish, unaffected by water, at a very moderate expense The paper was discussed by Messrs. Barber, Hermann, Richardson, Porter and others.

After adjournment the members visited the electric light mast which was wrecked by the storm a short time before.

Engineers' Club of Cincinnati.—At the regular July meeting Alfred Allen Stuart, Resident Engineer of the Central Railway & Bridge Company, Newport, Ky., was elected to membership.

It was decided not to adjourn during the months of July and August.

The paper for the evening was by Mr. Ernst Lietze under the title of Distribution of Power from a Central Station, in which he gave an exhaustive resumé of the various methods of transmitting power for mechanical purposes, and a comparison of the results derived from each. He also presented numerous formulæ and calculations and tables deduced from them showing the specific duties, efficiencies, etc., for the various systems. The second part of the paper comprised a detailed description of the Pneumatic Power Supply of the *City of Paris*.

Engineering Association of the Southwest.—At the regular meeting in Nashville, Tenn., July 10, a Committee was appointed to represent the Association at the Road Congress, which will meet in Nashville, August 26.

An address on Captain James B. Eads, prepared by Mr. E. L. Corthell, was read, and the Association was requested to contribute to the monument to be erected to Captain Eads in St. Louis.

A Committee was appointed to make arrangements for the visit of the Iron & Steel Association of Great Britain, which, under the present programme, will reach Nashville, October 15, and will go from that place to Knoxville, Birmingham, Anniston and other places farther South.

It was resolved to appoint a Committee of three to draft a bill to be presented to the next Legislature to remove the tax at present levied on engineers and architects. There was some discussion showing the injustice of such taxes, while members of other professions are free from the burden.

Western Society of Engineers.—At the regular June meeting in Chicago action was taken on a report presented by the Committee on an International Engineering Congress. It is proposed to hold this Congress in Chicago at the time of the World's Fair, and to invite engineering societies in other countries to send delegates. A committee was appointed and communications sent to the American Society of Civil Engineers and other societies.

Engineers' Club of Minneapolis.—At the regular meeting in June Professor W. A. Pike was appointed to represent the Club at the convention of the American Society of Civil Engineers at Cresson.

Mr. Walter S. Pardee read a paper on the Ventilation of School Buildings, which was illustrated by numerous diagrams. This paper was discussed by the members present.

Engineers' Club of St. Louis.—At the regular meeting, June 18, a special committee was appointed to consider amendments to the agreement of the Association of Engineering Societies.

The Secretary read a paper on River Pollution in the United States, by Professor Charles C. Brown, in which the subject was divided into three heads: First, streams used for water-supply only; second, streams used for drainage purposes only; third, streams used for both water-supply and drainage. The paper was confined principally to the consideration of the latter class, it being the most important. The author gave abstracts of the work done in different States heretofore, in the direction of investigating the pollution of streams, accompanying his remarks by tables showing the results of chemical analysis of a large number of different waters. The author said he would be glad to receive further data, and asked for criticism and discussion of the subject. The paper was briefly discussed by members present.

Engineers' Club of Kansas City.—At the regular meeting, June 9, the President tendered his resignation, but was requested to withdraw it.

The meeting was taken up by a general discussion on the subject of Gas Engines, in which nearly all the members present joined.

Technical Society of the Pacific Coast.—At the regular June meeting in San Francisco four new members were elected. Mr. C. D. Hervey exhibited some new water pipe fittings. Arrangements were made for examining electrical apparatus and an electric light plant

Professor Irving Stringham read a paper on Napier's Definition of a Logarithm, and its Consequences. This was generally discussed by members present.

NOTES AND NEWS.

Wet and Dry Steam.—The researches of Professor Denton, of the Stevens Institute, Hoboken, N. J., have proved that when a steam jet is discharging freely into air from a nozzle, if a gap is observable between the visible cloud and the nozzle, then the steam is practically dry, and may also be considered practically dry even if the vapor is very faintly visible; but immediately it becomes distinctly white the water present has risen to from 1 to 2 per cent. These facts are most valuable in making rapid tests as to relative dryness, and the test is unexpectedly delicate. We were all in the habit of considering steam drier the more blue the appearance of the jet, but we were unaware of the accuracy of the test.

Case Hardening in America.—A writer in the London *Engineer*, commenting on the reversing levers in use on American locomotives, says: "The pins are not large enough, and the case hardening is rarely first-class. It is done in a very primitive manner, and it is seldom, indeed, that a well-designed case-hardening plant is met with. It is an art which does not receive in America the attention its great value so justly merits."

The Nicaragua Canal.—The directors chosen at the recent annual meeting of the Nicaragua Canal Construction Company are: Warner Miller, A. C. Cheney, Alfred M. Hoyt, W. L. Scott, J. F. O'Shaughnessy, J. W. Miller, R. A. Lancaster, J. L. Macauley, N. K. Fairbanks, Smith M. Weed, Henry R. Hoyt, Robert Sturgis, Edward Holbrook. The board elected the following officers: President, Warner Miller; Vice-President, A. C. Cheney; Secretary, J. W. Miller; Treasurer, Henry R. Hoyt.

The accounts of progress from the line of the canal continue to be very good.

The New Hatteras Lighthouse.—The bids for the construction of the new lighthouse on the Outer Diamond Shoal, off Cape Hatteras, were opened at the office of the Lighthouse Board in Washington, July 1. Some description of this lighthouse has already been published in our columns. It will be a work involving some time and trouble, on account of the difficulty of making the foundations. Four bids were received, as follows: Theodore Cooper & Company, New York, $474,000, work to be completed by January 1, 1893; Anderson & Barr, Jersey City, $485,000, to be completed January 1, 1892; Will-

iam Sooy Smith, Chicago, $488,325, to be completed in three years; James Andrews and Gustav Lindenthal, Pittsburgh, $1,820,300, to be completed in two years. Taking time into account, the bid of Anderson & Barr may be considered the lowest. All the bidders have had much experience in difficult foundation working, and the firms of Anderson & Barr and William Sooy Smith are constantly engaged in such work.

The remarkable thing about the bids is that three of them should be so close together, while the fourth is for nearly four times the amount of the lower bids. It must be remembered that this will be, as stated above, a very difficult piece of work, on account of the shifting and uncertain nature of the shoal upon which the lighthouse is to stand, and also of the fact that the work must be done practically at sea, and on that stormy coast the time is very uncertain, as it will be possible to work only in very fine weather.

Railroads of Europe.—The following table gives the total length of railroad lines in operation in Europe on January 1, 1889, the latest date to which official figures are attainable. The figures are given by *les Annales des Ponts et Chaussées*. The first column gives the length of railroad in miles; the second the length of railroad, in miles, opened in 1888, and the third the per cent. of increase during that year.

RAILROADS OF EUROPE.

	Country.	Mileage, January 1, 1889.	Increase in 1888.	
			Miles.	Per cent.
1	Germany	25,213	608	2.5
2	France	21,912	644	3.0
3	Great Britain and Ireland	19,918	221	1.1
4	Russia	18,278	557	3.1
5	Austria-Hungary	15,989	637	4.0
6	Italy	7,675	473	6 6
7	Spain	6,008	110	1.9
8	Sweden and Norway	5,648	86	1.6
9	Belgium	3,000	91	3.1
10	Holland	1,864	30	1.6
11	Switzerland	1,735	43	2.5
12	Roumania	1,538	77	5.3
13	Denmark	1,224	....	....
14	Portugal	1,189	52	3.6
15	Turkey and Bulgaria	1,024	159	18.3
16	Greece	988	13	3.3
17	Servia	321	....	...
18	Island of Malta	7	....	....
	Total	132,931	3,801	2.9

The countries are arranged in the order of their mileage. Only railroads actually in Europe are included; the lines extending into Asia—Russian Transcaspian, etc.—are omitted.

A Long Bridge.—One of the largest bridges at present proposed in the United States is to be built across the Columbia River at Vancouver, Wash., some 12 miles north of Portland, Ore. The bridge proposed is a low bridge with a long draw-span. Its length will be 3,600 ft., not including the approaches. At the point chosen for the bridge the Columbia River has a depth of about 25 ft. at low-water, the river being very wide and comparatively shallow.

The Forth & Clyde Canal.—Surveys have been completed for the proposed new canal across Scotland, which is to connect the Clyde River with the Forth, and to furnish a passage for ships across Scotland. The line proposed follows the valley of the Forth to Loch Lomond, near its southern end. From this point three lines to the sea are practicable: Through Loch Lomond to Loch Tarbet, and thence to Loch Long, which communicates directly with the ocean. The second is from Loch Lomond, through the Vale of Leven to the Clyde at Dumbarton and the third from Loch Lomond by a cut of about four miles in length to the Clyde at another point. If the canal is to serve ocean-going vessels chiefly, it is considered that the first line is the best. The total length of the canal from the point where it leads the Forth to Loch Lomond would be 38½ miles, but near the western end a tunnel 2½ miles in length would be required. The cutting west of Loch Lomond would depend upon the line adopted, varying from 1½ miles by the first line to 5½ miles by the second. It is proposed to make the canal throughout with a depth of 30 ft. of water and a width of 72 ft. at the bottom, the side slopes depending upon the nature of the ground. The locks would be large enough for vessels of the largest size. The cost is estimated at somewhere about $40,000,000, and it is expected that a very large traffic would pass through the canal, as there would be a great saving in distance for all shipping bound from the Clyde and from points on the west coast of England to points on the east coast of England and Scotland, and ports on the Continent. Moreover, the passage around the north of Scotland is a very dangerous one in bad weather, and there would be a considerable saving in safety as well as in distance. Abundant supply of water for the canal could be obtained from Loch Lomond, which has a large area, and contains a great body of water.

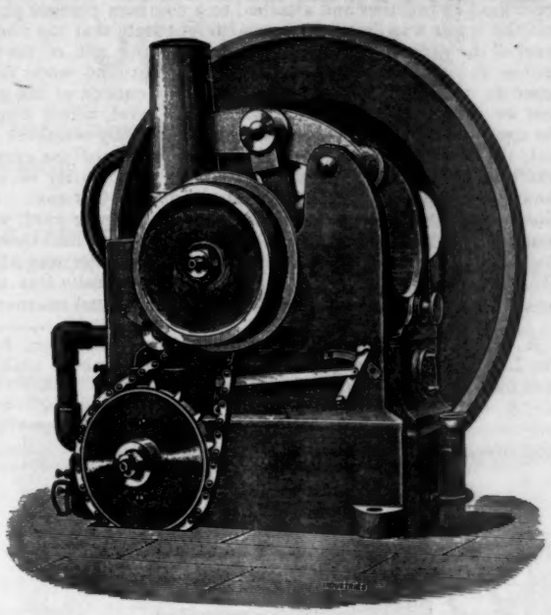
Large Railroad Systems.—In an elaborate article on the process of consolidation of our railroads into large systems, the *Commercial and Financial Chronicle* says: "The most striking results, however, are reached in summarizing the figures detailed above. Treating the Chicago & Northwestern and the various Vanderbilt lines east of Chicago as one interest, and treating the Gould and Huntington lines in the same way, we find that sixteen leading interests and corporations control 111,149 miles of road. If we take out the 10,867 miles in the Canadian Pacific and the Grand Trunk systems, over 100,000 miles of road would remain controlled or directed by only 14 interests and corporations. That is, about two-thirds of the entire mileage of the country is controlled by these 14 interests. The order of the interests is:

	Miles.
Vanderbilt lines, including Chicago & Northwestern	15,663
Gould lines, including Wabash, but not Central Branch U. P.	11,879
Huntington lines, east and west of Mississippi	9,038
Atchison and St. Louis & San Francisco	8,965
Union Pacific	8,047
Pennsylvania	7,664
Richmond Terminal	7,469
Chicago, Burlington & Quincy	6 883
Canadian Pacific	6,766
Chicago, Milwaukee & St. Paul	5,678
Chicago, Rock Island & Pacific	4,587
Northern Pacific and Wisconsin Central	4,429
Grand Trunk	4,101
Louisville & Nashville	3,827
Great Northern	3,278
Illinois Central	2,875
Total 16 interests and systems	111,149
Less Canadian Pacific and Grand Trunk	10,867
Total 14 interests in the United States	100,282

"Evidently under this process the work of our Interstate Commerce Commission is being greatly simplified. Evidently also, under the same process, many of the difficulties in the way of reconciling diverse and conflicting elements are being removed, thus bettering the general railroad situation and improving the outlook for railroad properties."

A Domestic Petroleum Engine.—The use of gas and petroleum engines is much more common in England than here, and many convenient forms have consequently been devised in that country. The accompanying illustration, from *Industries*, shows a little engine for house purposes, invented by Edward Butler, of Greenwich, England. This motor is very compact and is entirely self-contained. It stands on a base 12 in. long by 7 in. broad, and measures 16 in. to the top of the fly-wheel; these dimensions are smaller than those of any other gas engine in the market. It runs at 1,200 revolutions per minute without load, and at from 250 to 800 revolutions when doing work. The power developed is one-fifth of a horse-power. The explosive mixture is formed of the vapor of benzolene, together with a certain proportion of air. The cylinder is vertical and single-acting, and is 2 in. diameter by 3½ in. stroke. The piston is of the trunk type, with one end of the connecting rod attached to it. The upper end of the connecting-rod works a vibrating lever, which transmits motion by a second connecting-rod to the crank-shaft. The fly-wheel is at the back end of the crank-shaft, and the driving-wheel is at the front end. The fixed centers of the vibrating lever are on the same casting as the bed-plate. The lower part of the bed-plate forms a small reservoir for the benzolene, and this small receptacle is connected with the main reservoir, which is placed in any convenient position, by a pipe about ⅛ in. in diameter. In the present case about a quart is the capacity of the larger reservoir. From the small reservoir the benzolene is drawn up by a pipe about $\frac{1}{16}$ in. diameter, and the air, which is passed through a small

inspirator, mixes with it and converts it into an explosive mixture. The explosions take place at the bottom of the cylinder once in every two revolutions. The supply of vapor is controlled by a rotating plug valve with suitable inlets and outlets; this valve runs at one-fourth the speed of the crank-shaft, to which it is geared by an Evart's chain. Igniting sparks are ob-



tained by a current from a bichromate battery with carbon and zinc elements, and the current is transformed by an induction coil into one of higher pressure. Contact is made twice in every revolution of the valve, and as the valve only rotates at one-fourth of the speed of the crank-shaft, this is equivalent to one explosion in every two strokes of the piston. A small water-tank placed at a higher level provides the means for keeping the cylinder cool by circulating water around it. A tiny throttle-valve regulates the speed of the motor. An opening of $\frac{1}{100}$ in. in the valve is quite sufficient for the working of the motor, one-eighth of a turn on a screw with 50 threads to the inch giving this opening. It is stated that the amount of benzolene used is from ¼ pint to ½ pint per hour. The motor can be fixed on a kitchen table, shop counter, bench, or floor, and the small water tank on a shelf or bracket, while the battery, as in the case of house bells, may be conveniently placed in a cupboard or cellar. The motor is started by giving it a few turns by hand, after which it runs without further trouble.

Tests of the Iron of the Kieff Bridge.—In the summer of 1888 Professor Belelubsky was commissioned by the Russian Public Works Department to examine and report upon the condition of the Kieff suspension bridge, then about 40 years old, and particularly to examine the quality of the wrought iron used in its construction. Fortunately a certain number of spare links, which are 12 in. broad, 1 in. thick, and about 12 ft. long, had been preserved in the storehouse adjoining the bridge, so that it was possible to replace one of the original links by a new one, and to compare it with another unused one. Four test-pieces 1 in. by 1½ in. and 8 in. long were taken out of each link in the direction of the length, and one 4-in. piece transversely. The results were as follows:

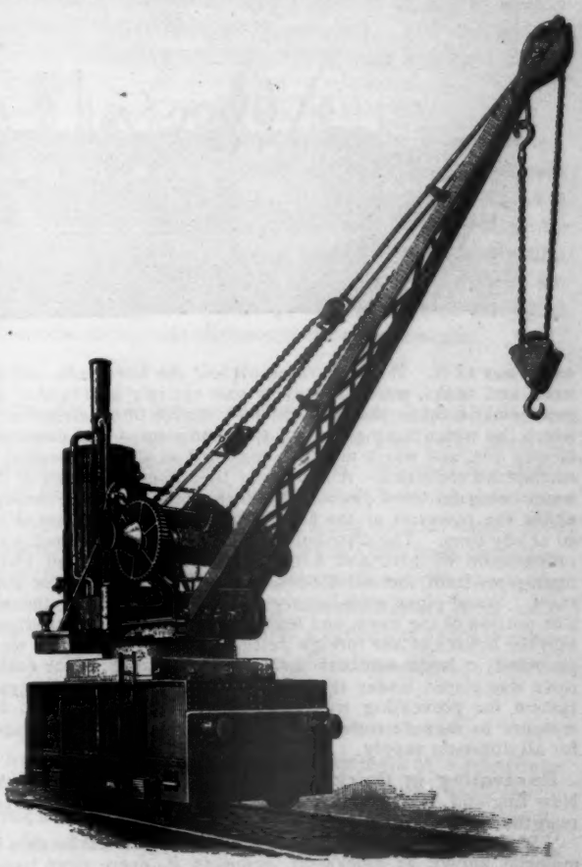
	Tensile Strength.	Elastic Limit.	Elongation.	Contraction.
	Tons.	Tons.	Per cent.	Per cent.
Link taken out of bridge—				
Mean of four longitudinal tests..	21.8	11.1	14.05	17.35
One transverse test.....	14.9	..	2.10	1.60
New link from store-house—				
Mean of four longitudinal tests.	22.2	11.93	13.42	18.75
One transverse test.....	17.32	..	6.00	6.80

The longitudinal tests show that the strength of the metal is substantially unchanged, in which respect they confirm the previous observations made by Professor Bauschinger, at Munich, upon the iron of old bridges. The Author recommends that in all new bridges provision should be made for comparative tests of the strength of the metal at long intervals by preserving some spare bars from the original construction.—*Stahl und Eisen.*

A Locomotive Steam Crane.—The accompanying illustration, from the London *Engineer*, shows a very compact locomotive crane, built by Mr. T. Smith, Bodley, England. This crane can lift 7 tons at 12 ft. and 4 tons at a radius of 20 ft. from the central pillar. It is mounted on a car or frame of wrought-iron plates and angles, carried on two steel axles, the wheels being set to 4 ft. 8½ in. gauge. The wrought-iron central pillar is turned to fit true in the base-plate, which is securely fixed in the frame. The jib is of wrought-iron plates and angles, and carries the necessary chain-wheels, shafts and gearing.

The hoisting motion is by double purchase spur gearing, controlled by clutch and lever, and is provided with a friction brake controlled by a foot lever. The jib-adjusting motion is by spur and worm wheels, geared up from the engine shaft, and controlled by a clutch and lever. The revolving motion is by spur and miter wheels, geared up from the engine shaft to the main internal wheel on the frame, worked by a double friction cone, so that the movement can be stopped or reversed without stopping the engine; it is controlled by a screw lever and light hand-wheel. The propelling motion is by gearing from the engine shaft to the traveling axles, and is controlled by a clutch and lever.

The engine has two cylinders, 7½ in. in diameter by 12 in. stroke, the valves being worked by a link motion. The boiler



is vertical, 3 ft. 9 in. in diameter and 8 ft. 6 in. high, and is provided with feed-pump and other appliances. Water is carried in a tank in the frame.

This crane is especially intended for ship-building work, but can be used for loading and other purposes as well.

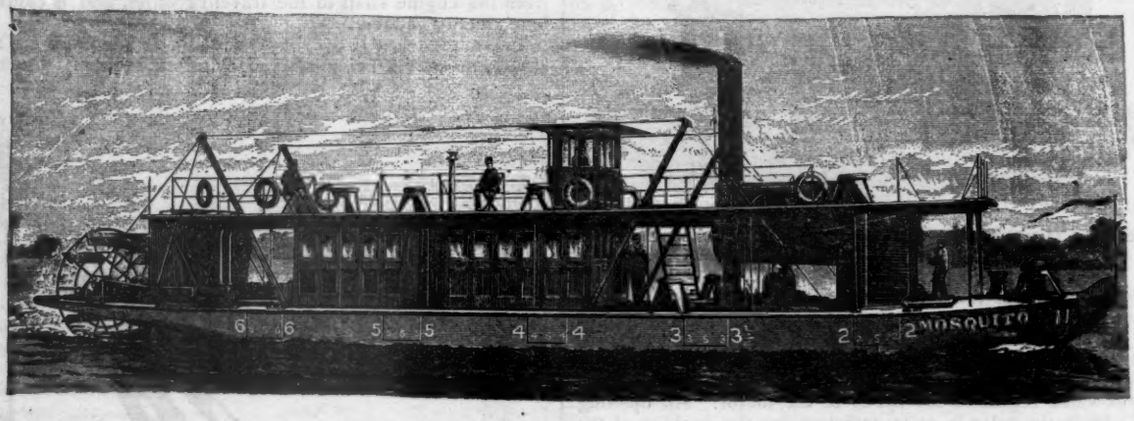
Water Works in Japan.—At the recent meeting of the Institution of Civil Engineers, Mr. J. H. T. Turner read a paper on the works for the water supply of Yokohama, which were completed in October, 1887. This was the first undertaking of the kind in Japan. Its inception was largely due to the recognition by the Japanese Government of the close relation subsisting between the use of polluted water and the development of choleraic epidemics at Yokohama. The principal original

features of the works were that they were constructed in a country subject to earthquakes, and to meet the peculiar requirements of a Japanese population. The source of supply was the river Sagami, which was tapped at a point about 28 miles distant from Yokohama. The water was raised from the river by steam-pumps, and was delivered into a depositing tank built on the mountain side. It passed from this tank through a gauge-plate into the aqueduct, and flowed by gravitation to the town. The upper portion of the aqueduct was composed of alternate lengths of 18-in. cast-iron main-pipe and masonry conduit, constructed along the precipitous rock wall of the Sagami cañon. The hydraulic gradient of the first 18 miles of the aqueduct was 6 ft. per mile, and of the last 9 miles, 14 ft. per mile, the diameter of the main-pipe being reduced to 15½ in. Lead joints were employed everywhere except at the river crossings, where flange joints were adopted. The main-pipe delivered the water to the filter-beds and service-reservoir, which were situated at Yokohama, about one mile from the center of the town. The filter-beds were three in number, two being ordinarily in use together; they were built of concrete. The filtering material consisted essentially of a depth of 2 ft. 6 in. of sharp sand, supported in the usual way upon gravel, and underlaid by brick drains. The service-reservoir was a concrete structure, the walls being faced with brickwork. The depth of water was 18 ft. Both the reservoir and the filter-beds, and all wells and tanks, were built upon and entirely surrounded by good puddle up to the water-line—a feature of construction to which the water-tightness of all these structures was doubtless largely due, and which might be regarded as almost essential in earthquake countries. A system of by-passes permitted of the water being delivered direct to the town, without passing through either the reservoir or the filter-beds, if it was necessary to do so at any time. The distribution in the town was effected by a ramification of 4-in. and 8-in. pipes branching off an 18-in. main-pipe from the service-reservoir. The service was constant. Stand-pipes were largely used for the supply of the native portion of the town, and lead service pipes were introduced into the houses of the foreign settlement. Fire hydrants were provided in large numbers throughout the town. The entire town was placed under the control of the waste-water meter system for preventing waste of water. Water was sold by measure to manufactories and shipping, the town being rated for all domestic supply.

Excavating in Quicksand.—At a recent meeting of the New England Water-Works Association, Mr. Albert F. Noyes read the following note:

"Some years ago I had occasion to make an excavation in material known as quicksand, some 15 ft. deep, near buildings. If the excavations were made in the ordinary way, a settlement of the foundations would be likely to occur, so I adopted the following method, which in my case proved successful; and I see no reason why, under similar conditions, and in a great many cases, it could not be used to advantage. The excavation, as I have said, was about 15 ft. deep, about 60 ft. in length, and 8 ft. wide. Usually below these veins of quicksand there are veins of a coarse material which form ready conductors for the water, and the vertical distance through the quicksand is usually less than the horizontal distance; the ground water has the least resistance in the vertical direction, and tends to soften and take up the quicksand with it. If the water is drawn out, or the water level lowered below the bottom of the trench, this fine material becomes compact, very much like clay, and excavations can be easily made with perfect safety and the use of a light sheeting. In the case I refer to I used 14 pipes 1¼ in. in diameter, and these were driven equidistant about the excavation to be made, with the ordinary perforated well point, having attached outside a fine-mesh brass screen. They were driven into a stratum of coarse material from 35 to 50 ft. below the surface of the ground. The pipes were ganged together and attached to a common plunger pump, and the water was drawn down. I might state that the normal level of the ground water was within some 3 or 4 ft. of the surface of the ground, so we had to draw the ground water down some 10 or 11 ft. We found by test tubes outside of the gang that we could readily hold the water to a level, which insured the excavations being made without any difficulty whatever; in fact, the banks were dry, and the lower portion of the excavation was very firm. In this case the well points, after we used them, were sold to other parties at nearly the first cost. The pipes, which were taken from the stock at the pipe-yard, were returned and used over again, so that there was little loss in that way; and the whole cost of driving the pipe was about $18, so that the expense of that method was really less than sinking a well outside of the excavation in the usual manner."

A River Gunboat.—The accompanying illustration, from the London *Engineering*, shows a light-draft gunboat built by



Yarrow & Company, Poplar, England, for service on the Zambesi River in Africa. The *Mosquito*, as the boat is named, recalls some of the boats prepared for river service during our own war.

The dimensions of this boat are: Length over all, 89 ft.; length of hull, 77 ft.; beam, 18 ft.; depth, molded, 4 ft.; draft in working trim, 1 ft. 6 in. The boat can run 10 miles an hour, which is as high a speed as is at all practicable when navigating a very shallow river, the channel of which is not known, and where there are no pilots. The boiler, which is placed forward, is of the locomotive type, and is adapted for burning wood, which is the only fuel obtainable up the rivers in East Africa. The weight of this boiler at the bow is balanced by the wheel and horizontal engines aft, which are of very simple construction. On the main deck are cabins and sleeping accommodation for the chief officer, three petty officers, and eight men, who will form the European crew, in addition to which hammocks will be swung from the upper deck for the accommodation of natives. On the top of the upper deck is placed the pilot tower, from which the steersman can obtain an all-round view.

The boat is built in floatable sections, each section being really a pontoon or tank, and of such a size as to render it easy of shipment in a ship's hold. On arriving at the destination each section will be lowered into the water, and then connected together by means of suitable straps and bolts, thus making the hull complete, after which the machinery and woodwork will be put on board.

The stern wheel is driven by two non-condensing horizontal engines, with cylinders 10½ in. in diameter and 30 in. stroke. The boiler is of the locomotive type, burning wood, and made to work at 140 lbs. pressure. The boat carries four 3-pounder Hotchkiss guns and six Nordenfelt machine guns.

Heavy Cables.—Among the heavy wire cables recently placed on the street car lines in San Francisco are one for the Castro Street line 1 5/16 in. diameter, 23,000 ft. long, and weighing 64,600 lbs.; one for the Market Street line 24 600 ft. long, weighing 64,555 lbs., and one for the Piedmont line 20,800 ft. long weighing 52,710 lbs. These cables were made in Trenton, N. J., at the Roebling Works.